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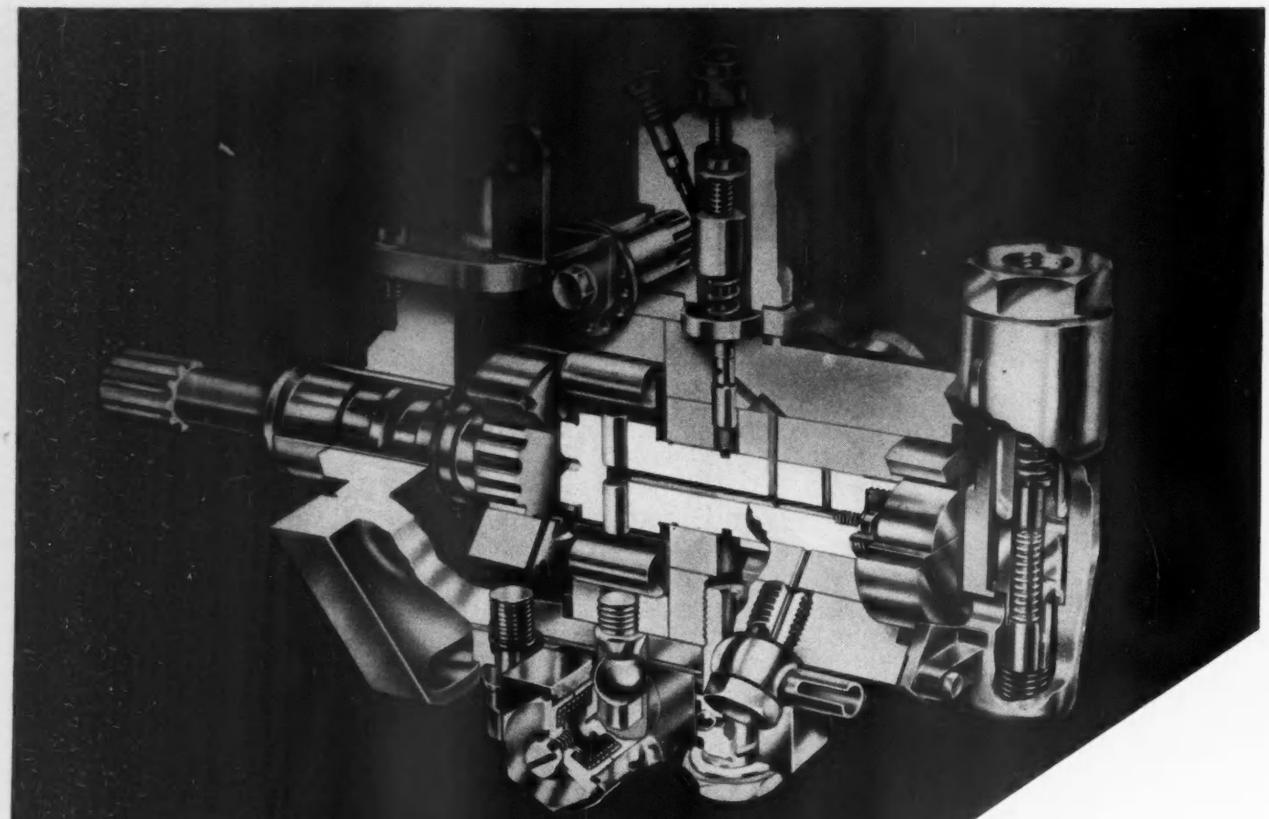

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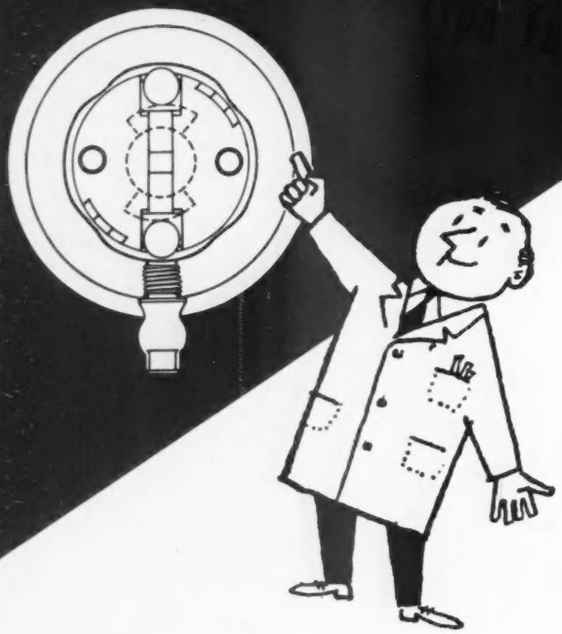

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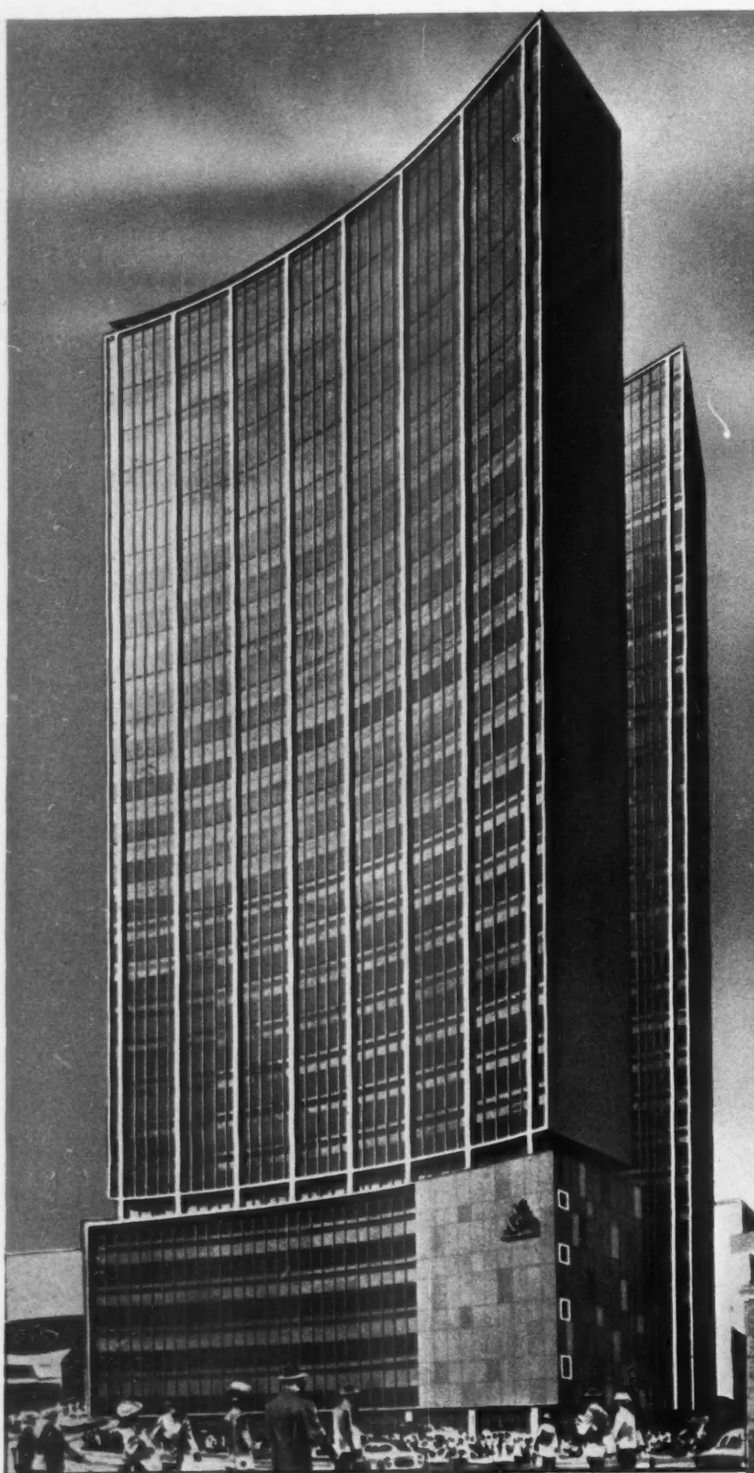

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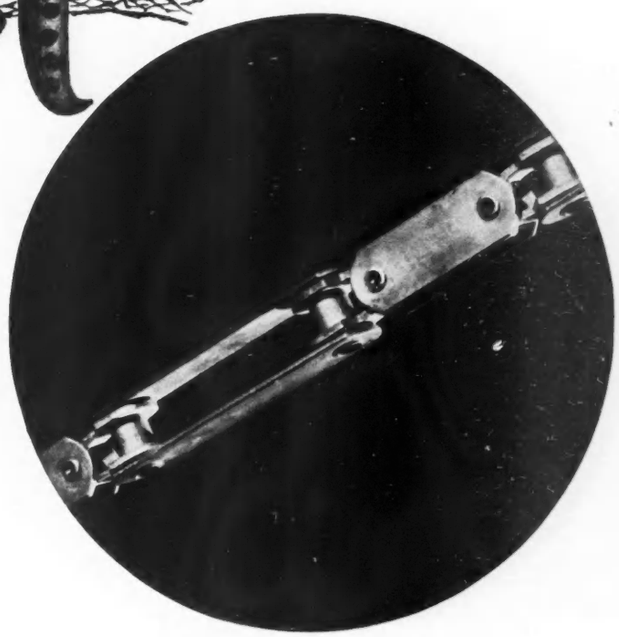

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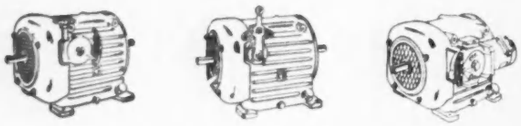

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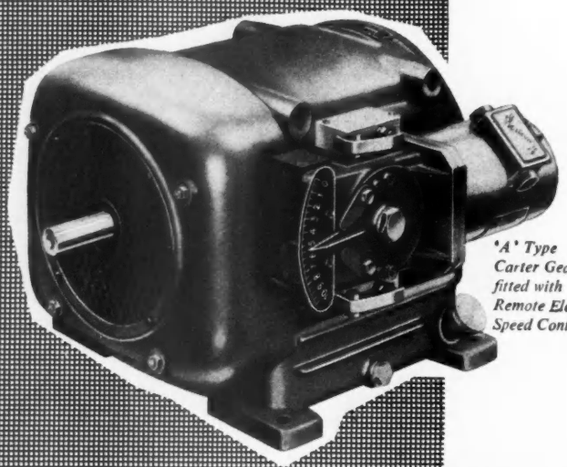

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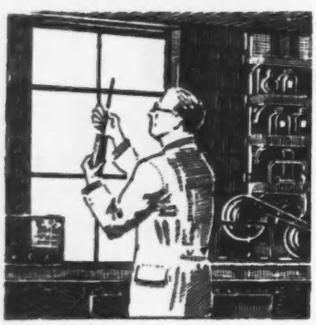

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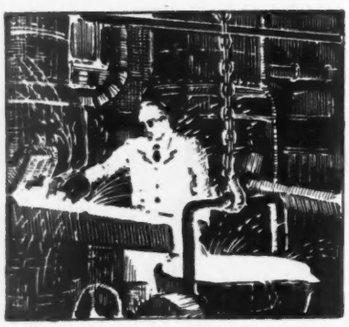

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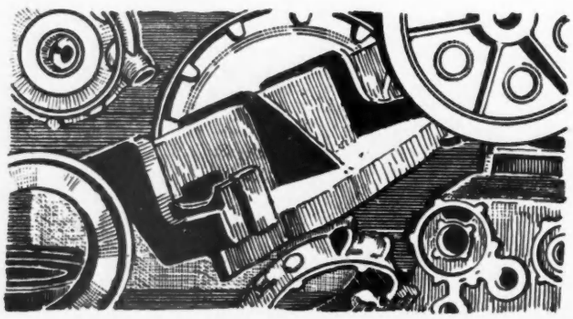

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Batches of manometers being photographed in a compressor test house. The cover picture shows one of the automatic cameras being loaded. (*Nurnberg photograph for* ENGINEERING)

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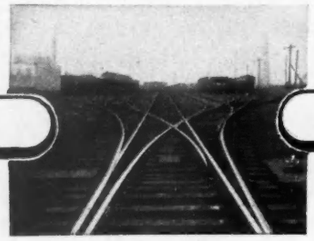

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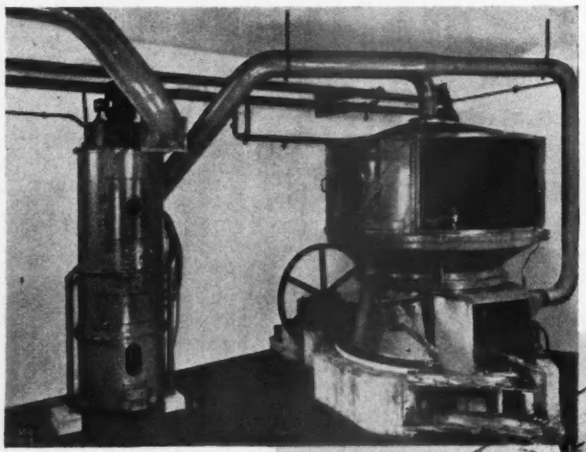

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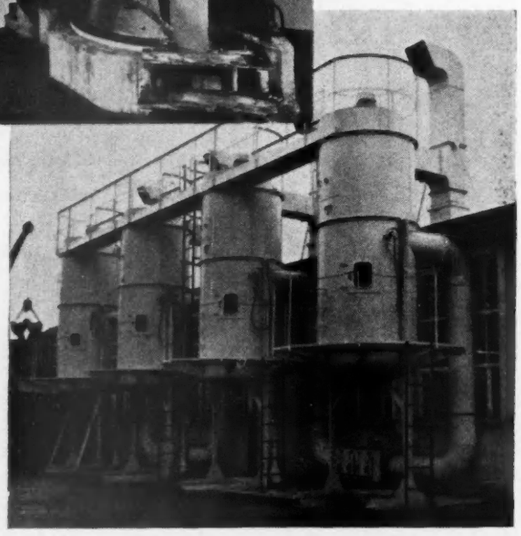

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The Electricity Corporation of Nigeria does not undertake to accept the lowest or any tender.

GEORGE W. NICOL,
Acting Secretary to the Corporation. C 545

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Specimen copy of the above enquiry can be seen at INDIA STORE DEPARTMENT, VEHICLES BRANCH, BROMYARD AVENUE, ACTON, W.3, under the following reference:—
S.3259/60/HEA/VEH C 566

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FOR THE SUPPLY OF TRACTORS, CRAWLER TRACK TYPE 55 DRAW BAR H.P.—REQUIRED BY ADDITIONAL DIRECTOR OF AGRICULTURE U.P., LUCKNOW, INDIA.

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(2) **One No. Double Head Catering Machine.**	Rs. 5/-=7/6	10.8.1960
(3) **One Swivel Head Vertical Slotting Machine.**	Rs. 7/-=10/6	17.8.1960
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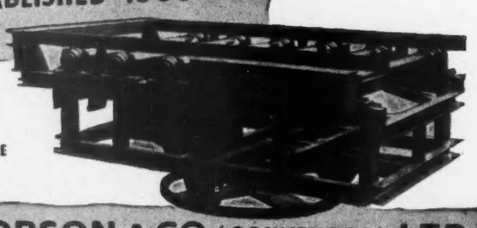

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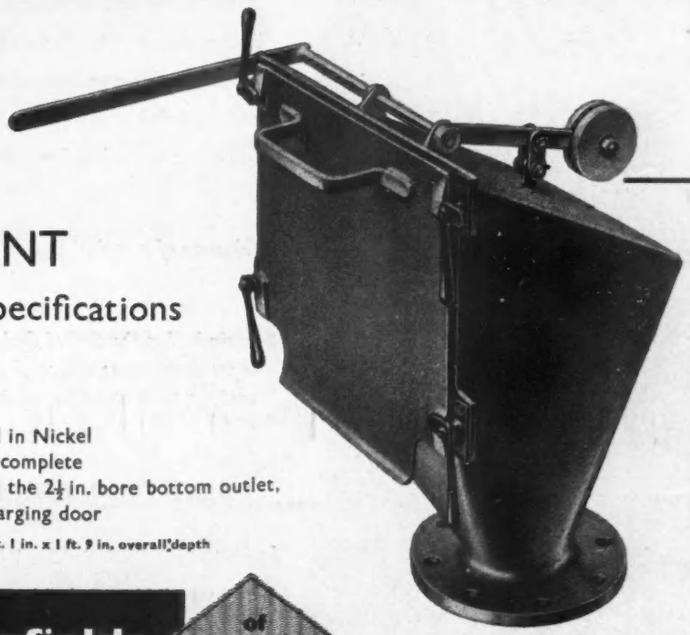

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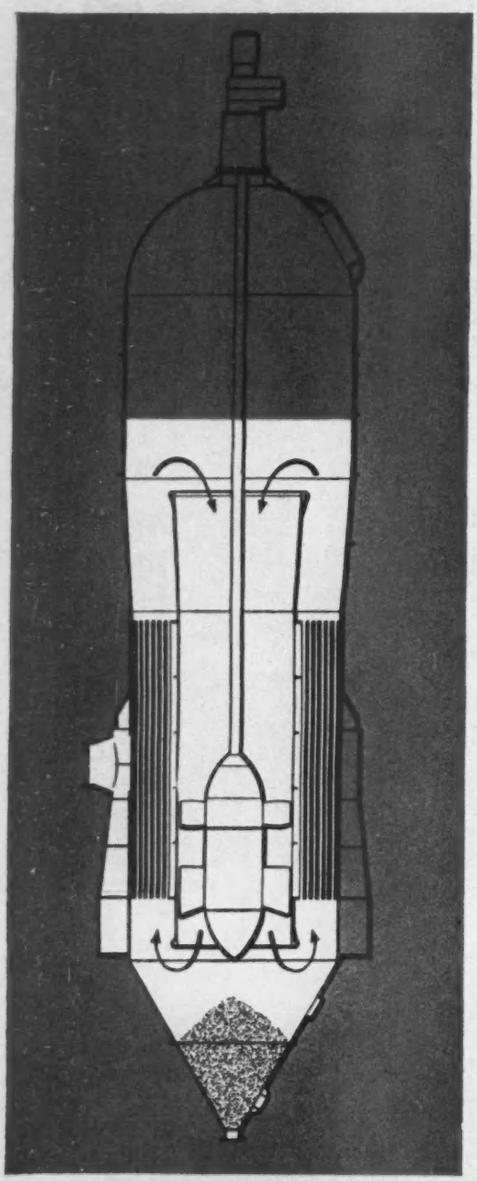

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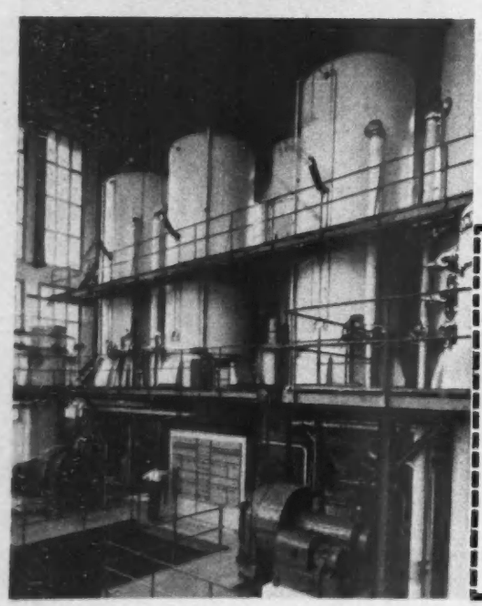

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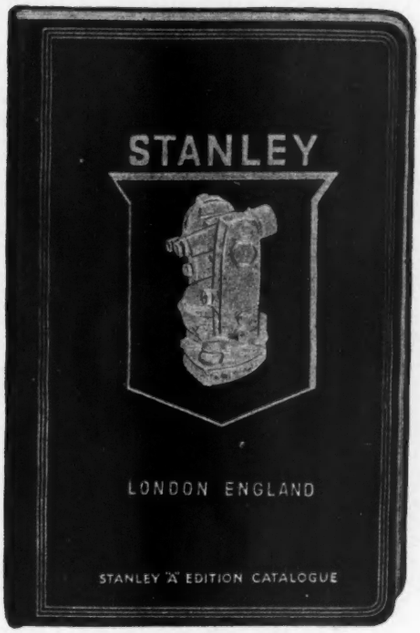

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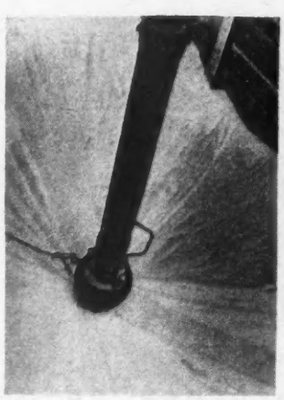

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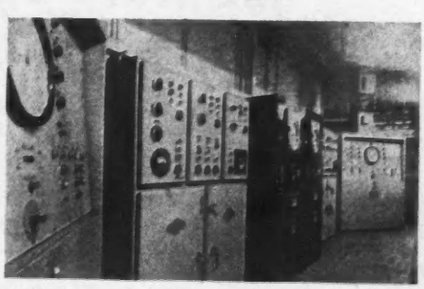

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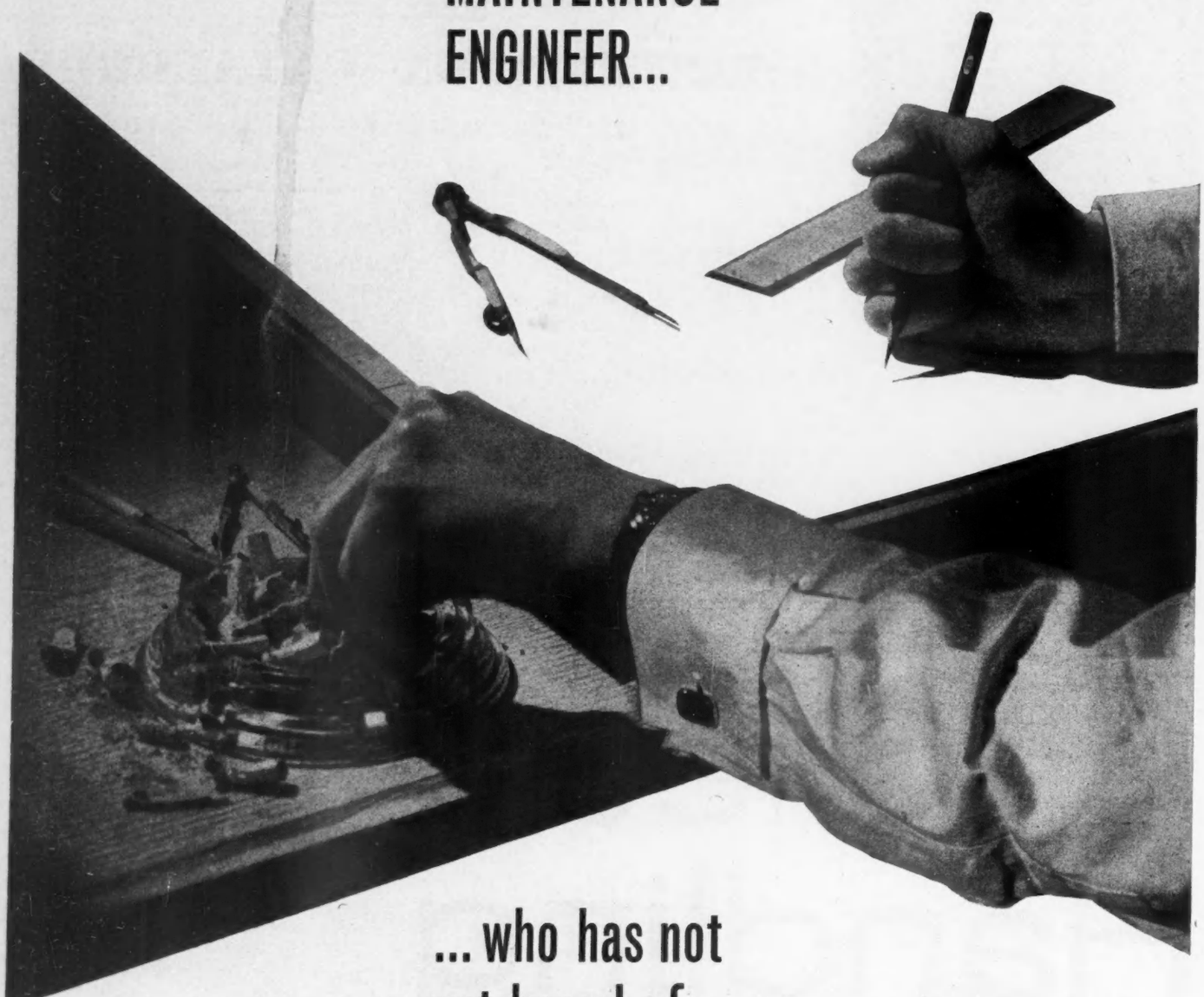

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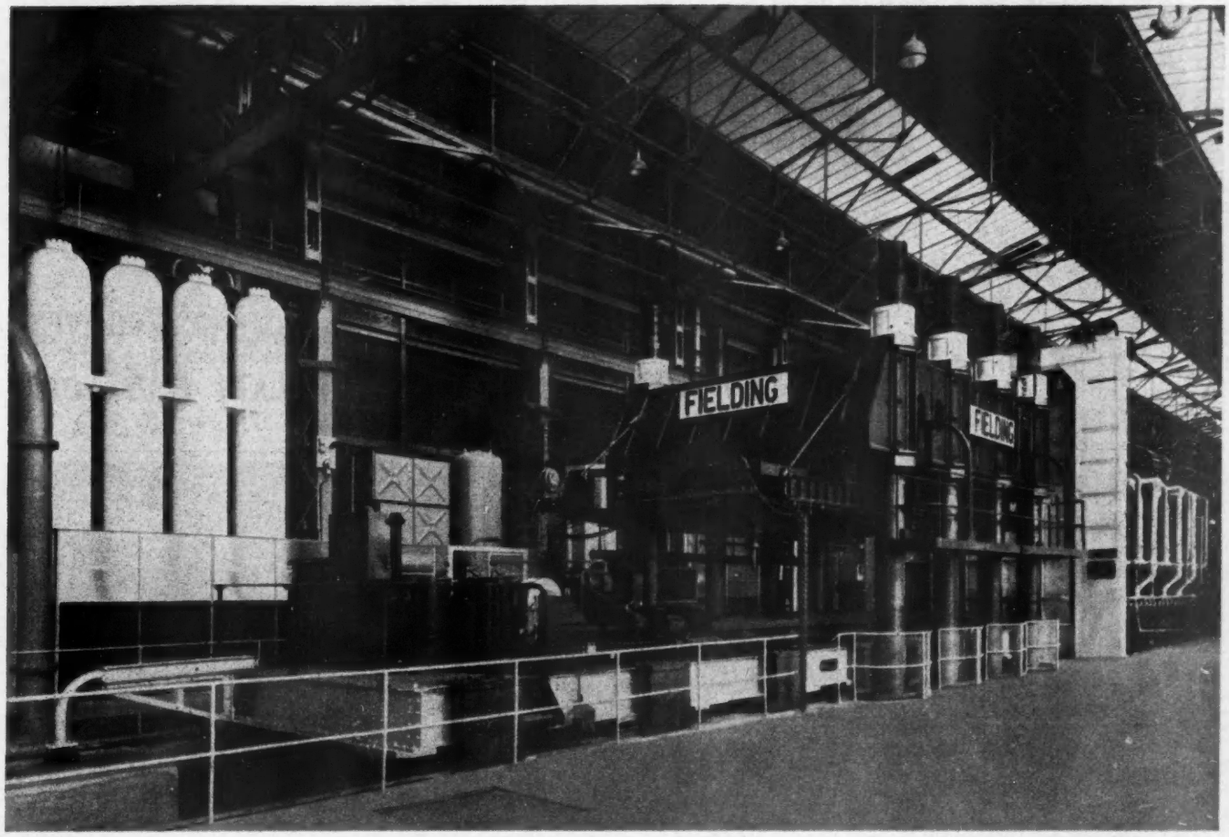

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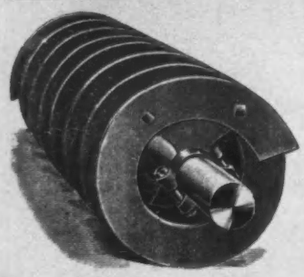

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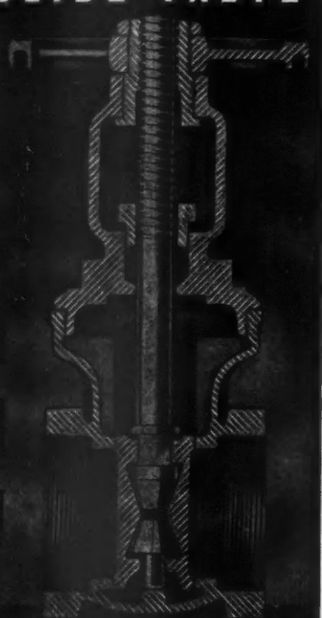

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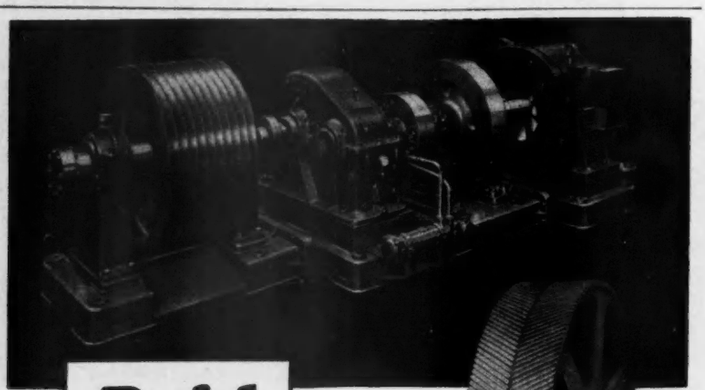

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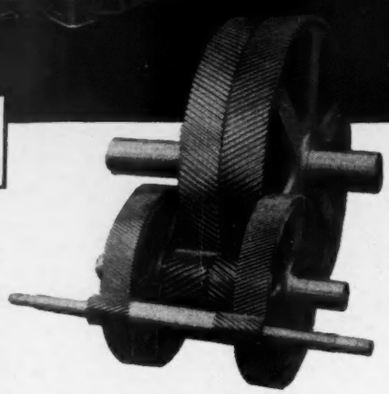

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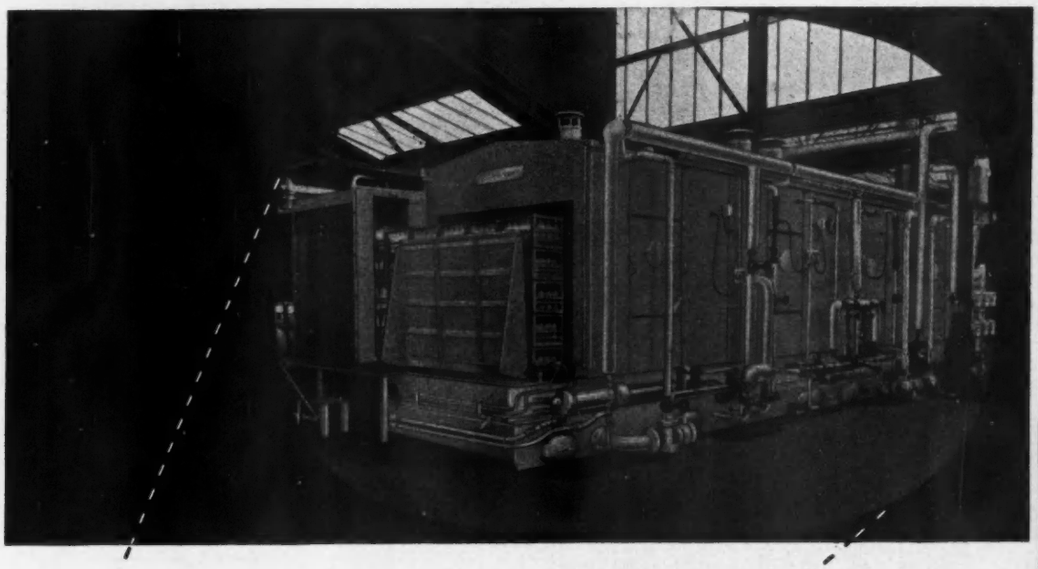

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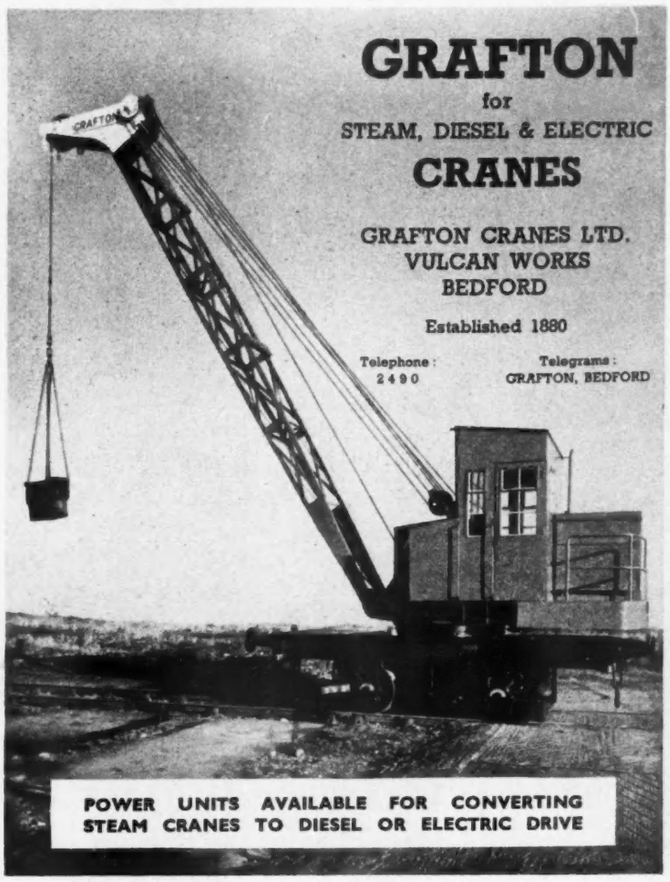

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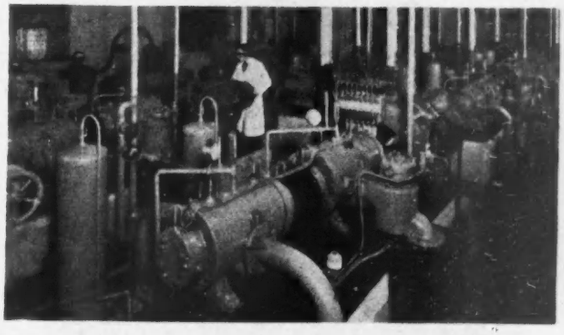

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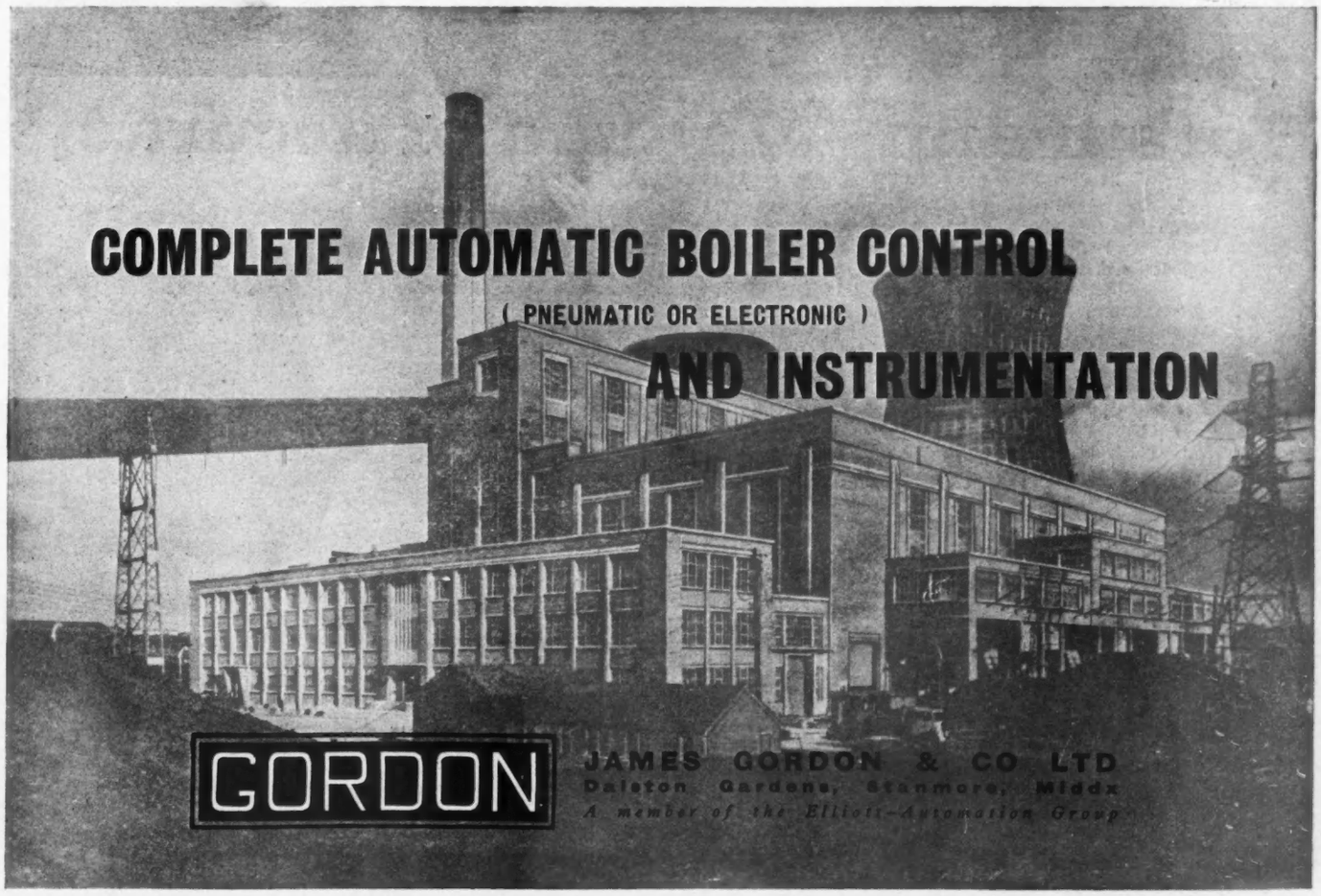

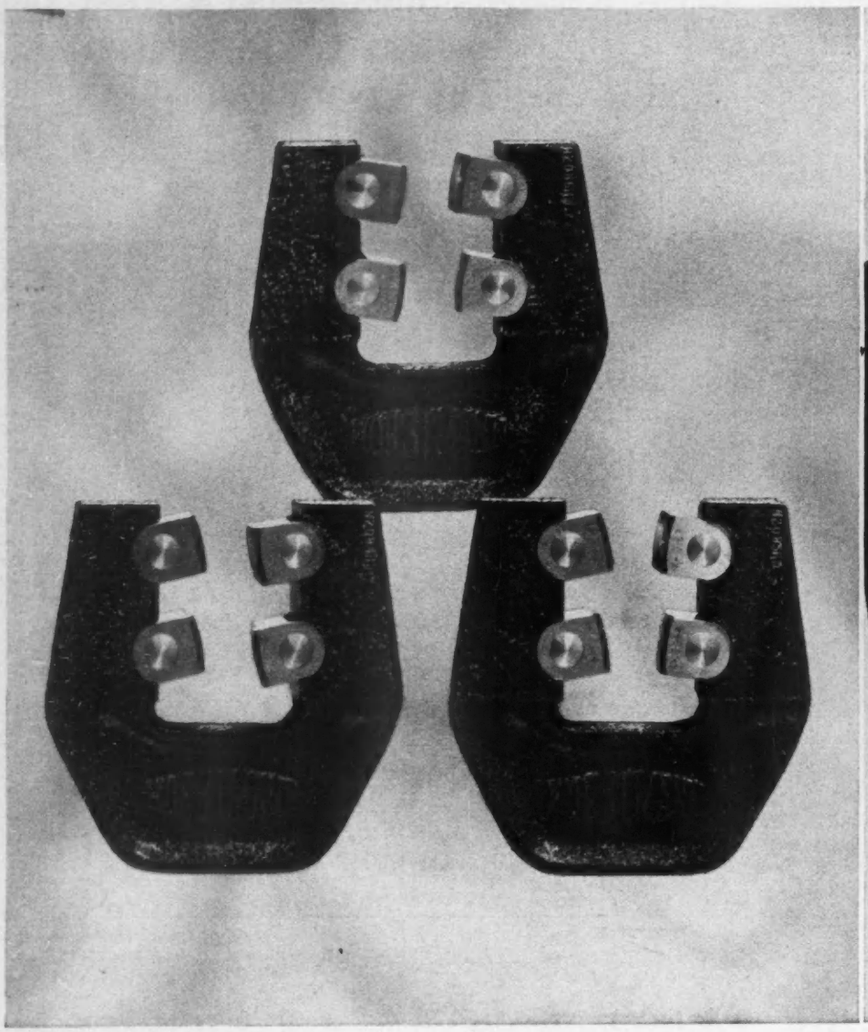

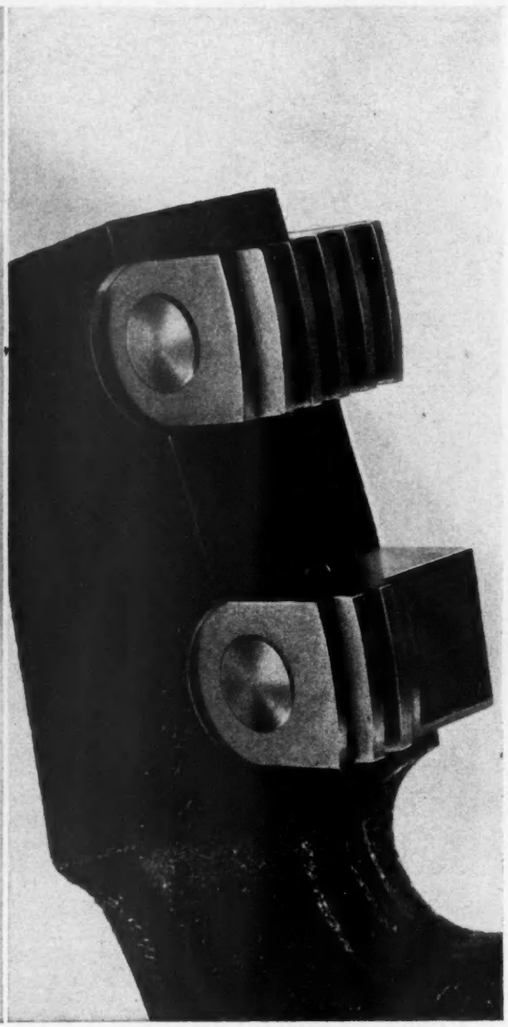

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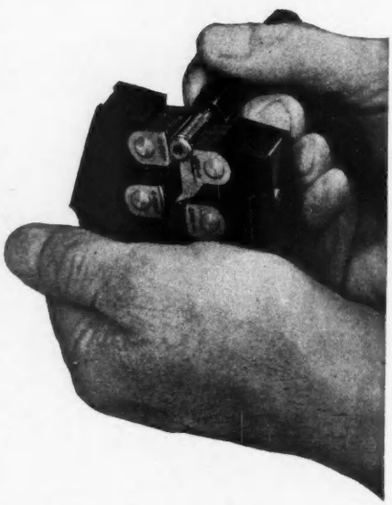

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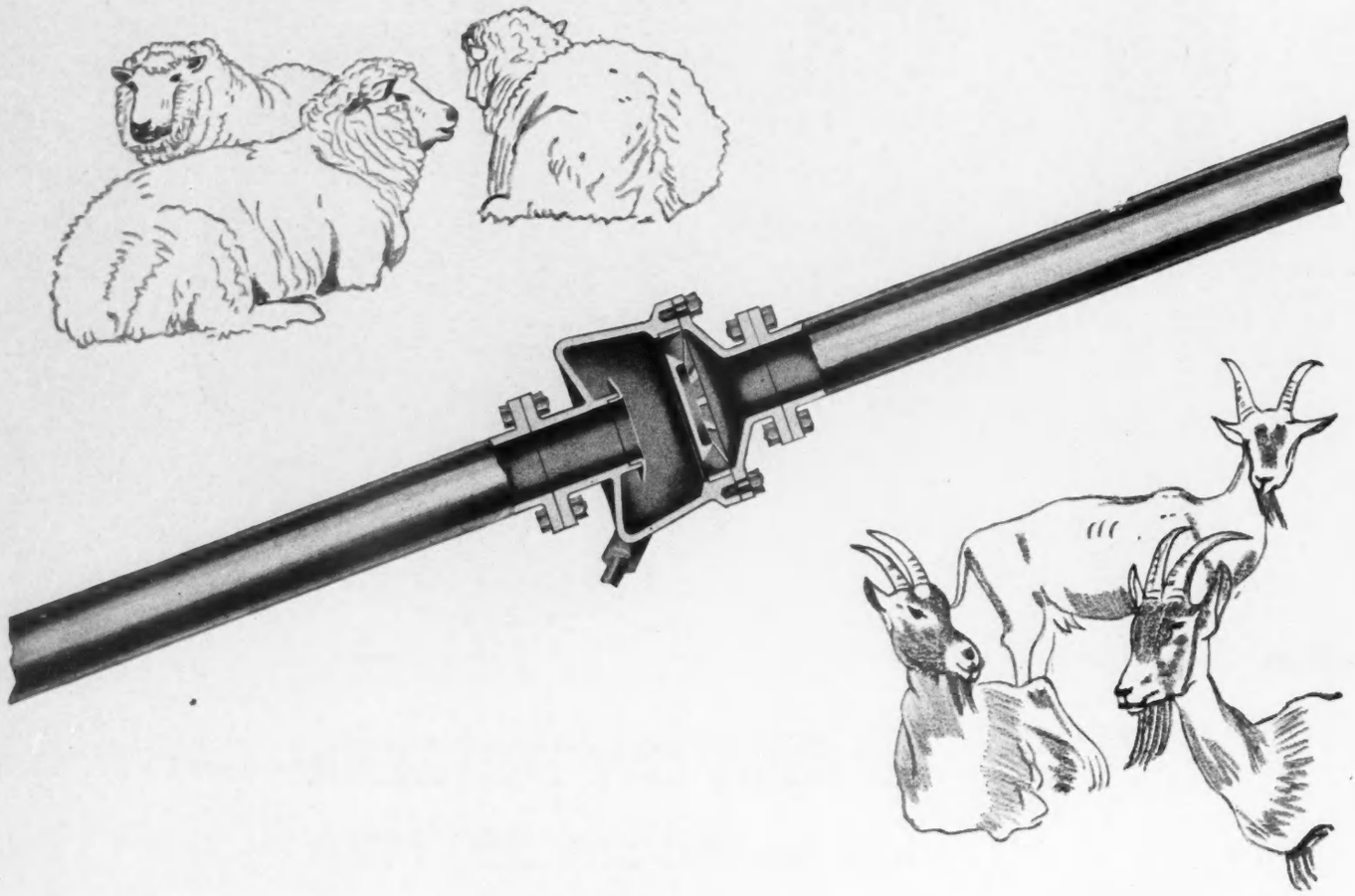

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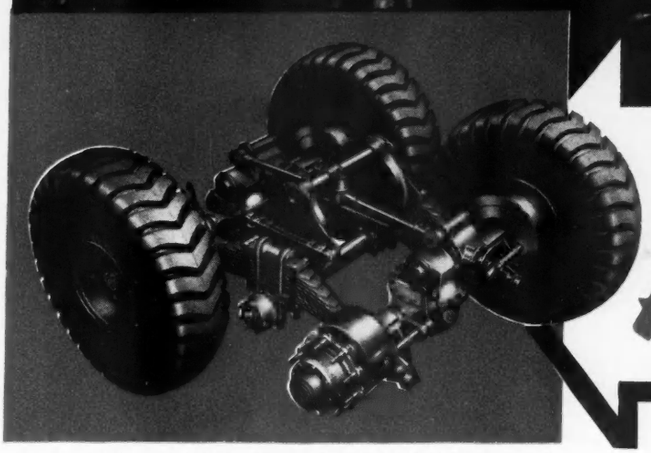

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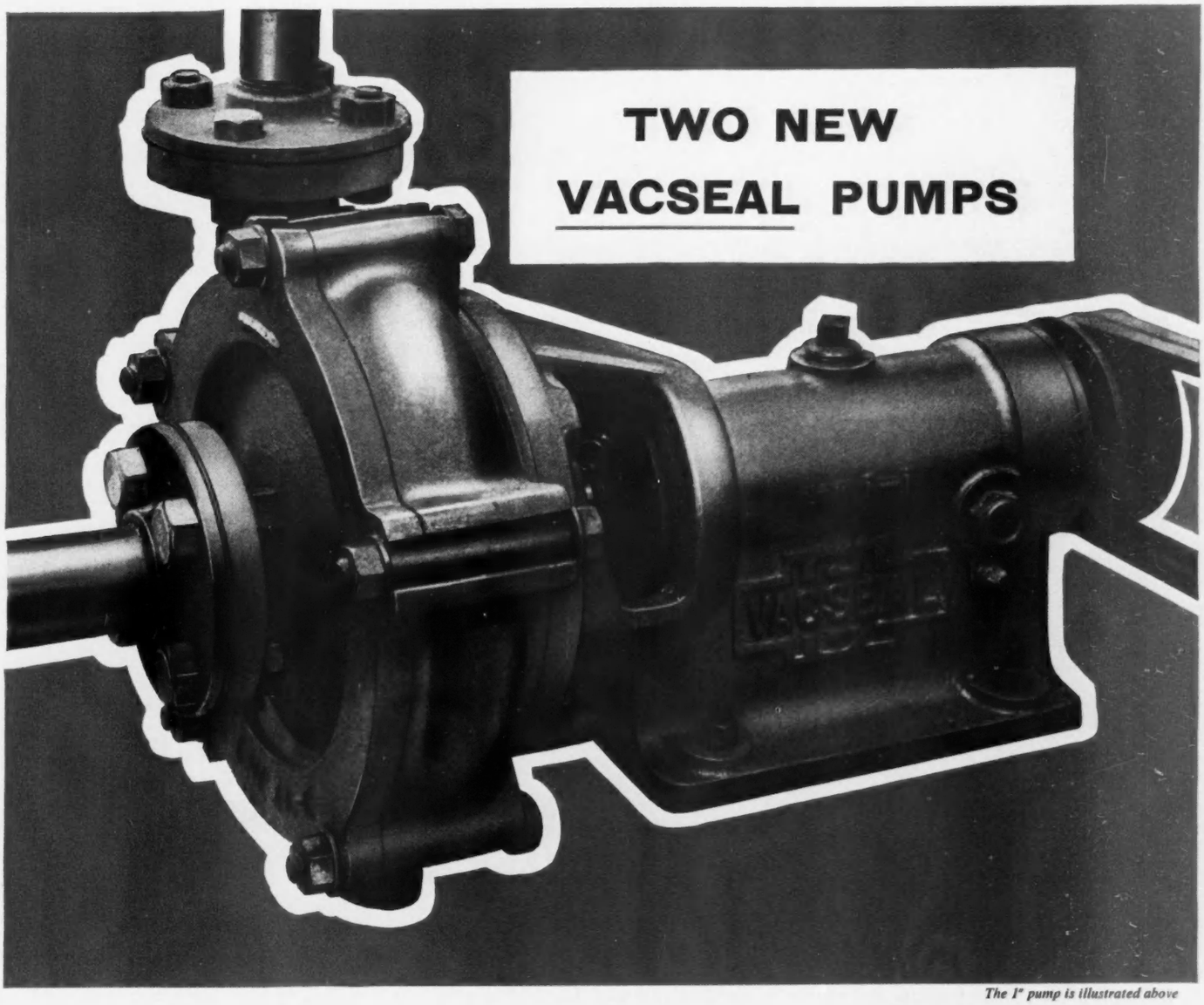

The 1" pump is illustrated above

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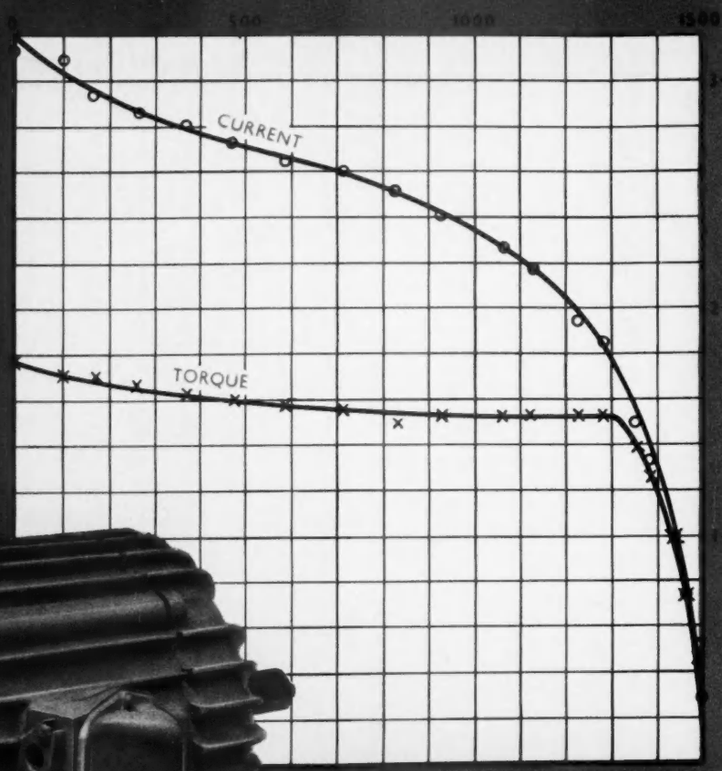

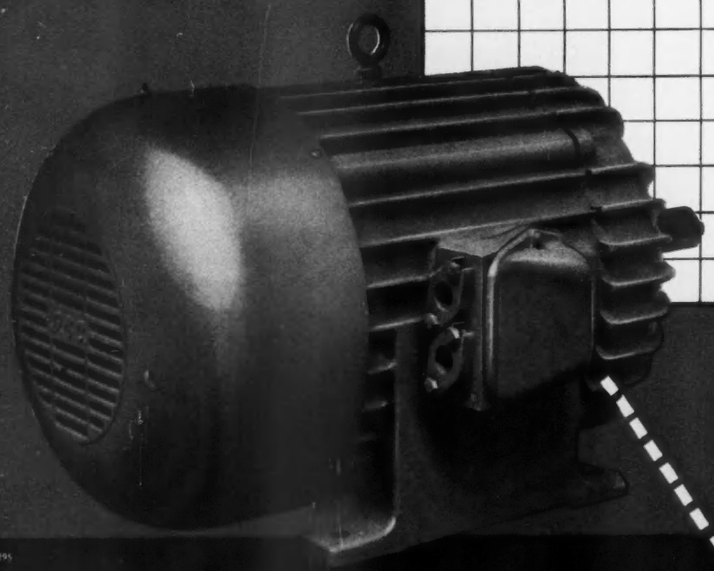

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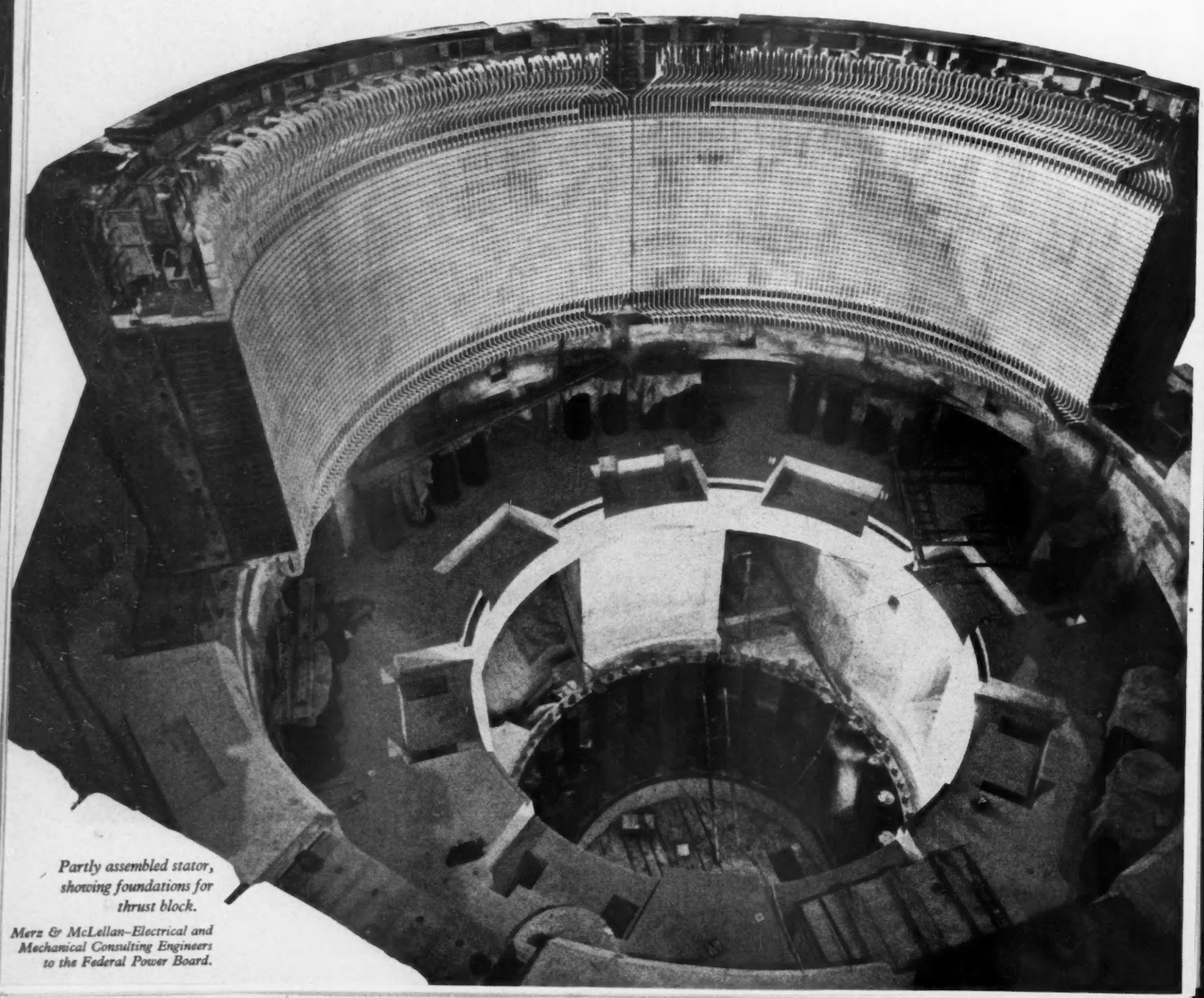
KARIBA—Electrical

THREE HUNDRED MILES downstream from Victoria Falls, where vast power goes to waste in a magnificent display, the waters of the Zambesi are being harnessed to supply electricity to the whole of Northern and Southern Rhodesia. The world's largest man-made lake, with an area bigger than the whole of the county of Kent, will store sufficient water power to generate 8½ million MWh of electricity annually. When the first stage of the plan is completed in 1962 six 100-MW generators will be in operation. By the early 1970's it is planned to raise the total generating capacity to 1,500 MW.

From Kariba this power will be distributed to the growing industries and cities of the Rhodesias and particularly to the Copper Belt.

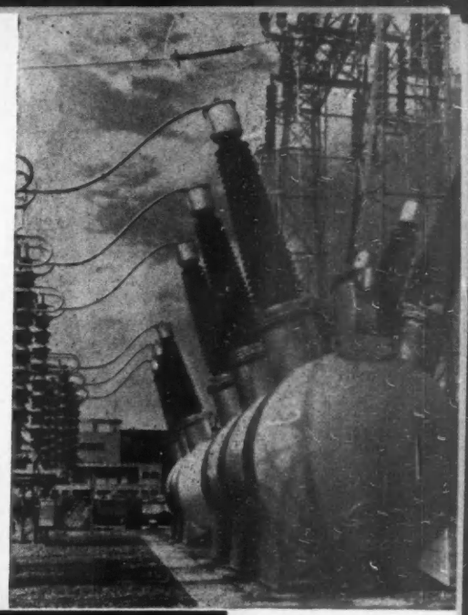
Much of the major electrical equipment for this great project is being supplied by AEI.



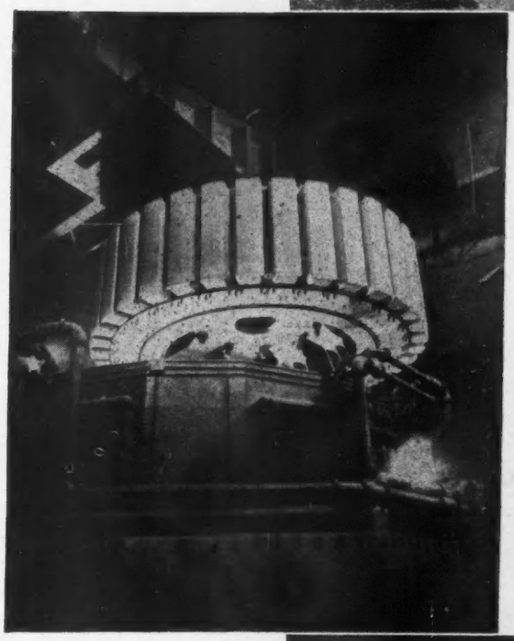
Partly assembled stator, showing foundations for thrust block.

Merz & McLellan–Electrical and Mechanical Consulting Engineers to the Federal Power Board.

Engineering on the Grand Scale



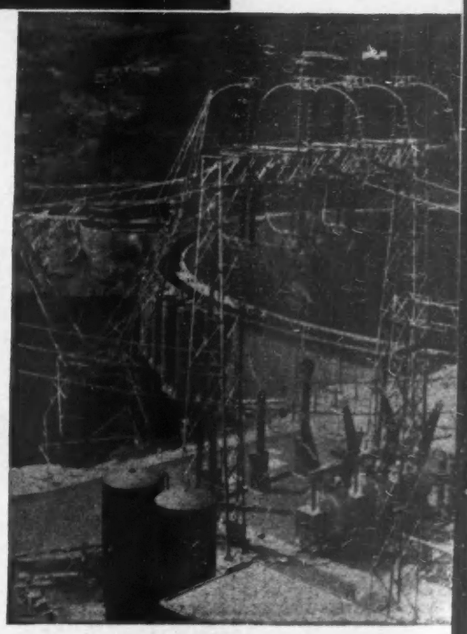
330 *kV* 7,500 *MVA circuit breakers at Kariba switching station.*



One of the six 100-*MW generator rotors being lowered into its stator.*

AT THE HEART OF THIS TREMENDOUS SCHEME are the six 100-MW AEI generators—the largest hydro-electric generators in Africa. Power is distributed at 330 kV which is the highest voltage to be used in the Southern hemisphere. For switching this power at Kariba and at the six sub-stations in Northern and Southern Rhodesia, AEI is to supply 25 oil circuit breakers, over 100 isolators and ancillary equipment.

AEI contracts also include the provision of 50 miles of cables, including control cables, co-axial and telephone cables and lead-covered cables for the underground power station.



A section of the 330-*kV switchyard at Kariba showing the equipment to control the feeder to Lusaka and Kitwe in Northern Rhodesia. The dam can be seen below.*

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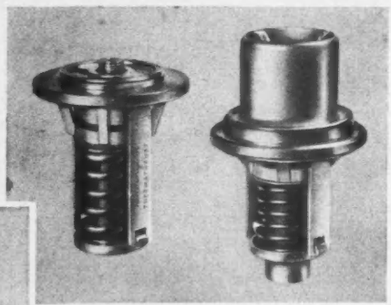

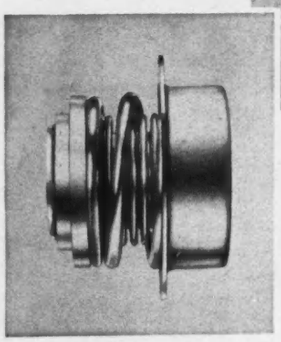

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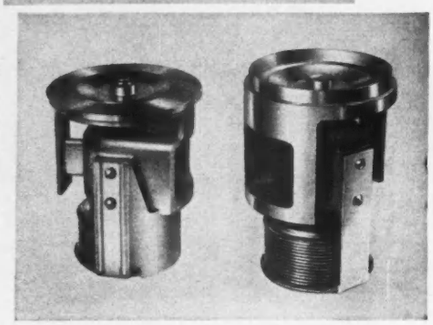
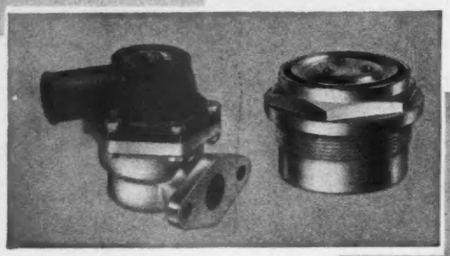


ENGINE COOLANT THERMOSTATS



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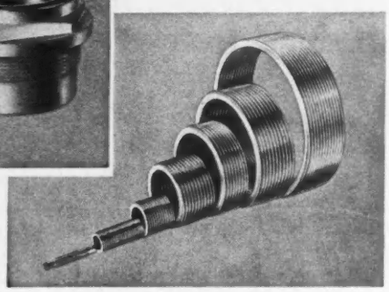

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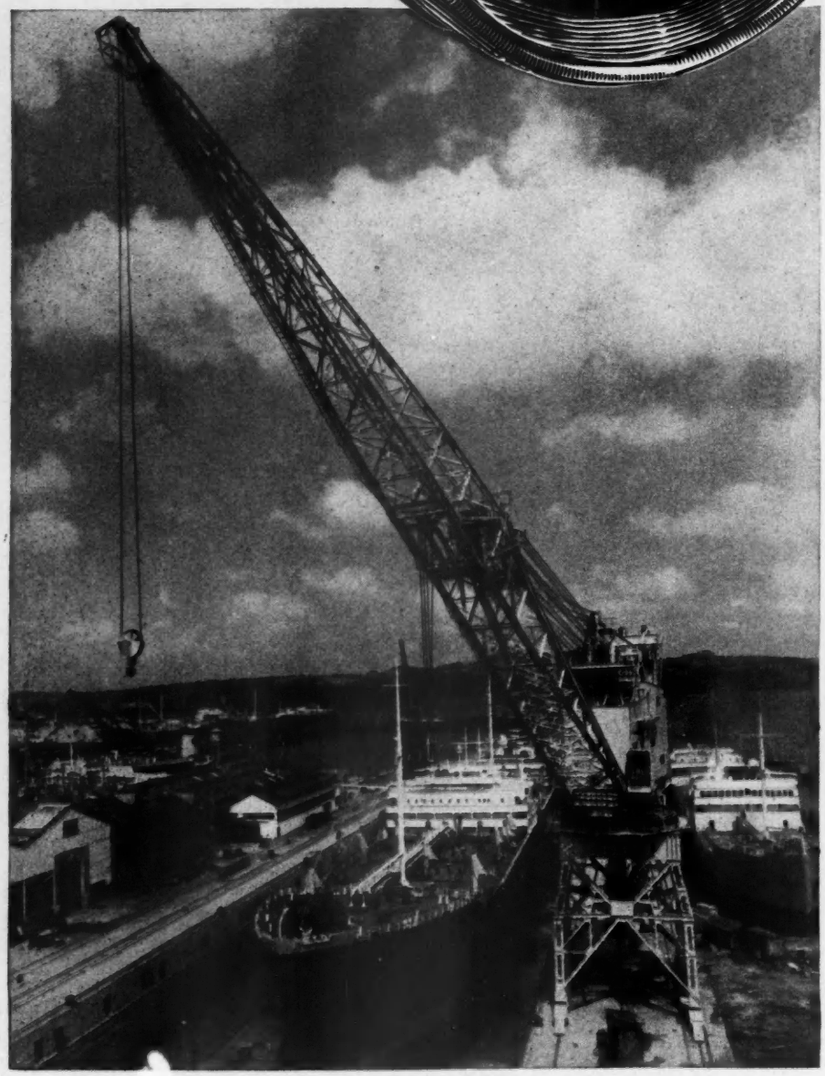

Focus on Falmouth

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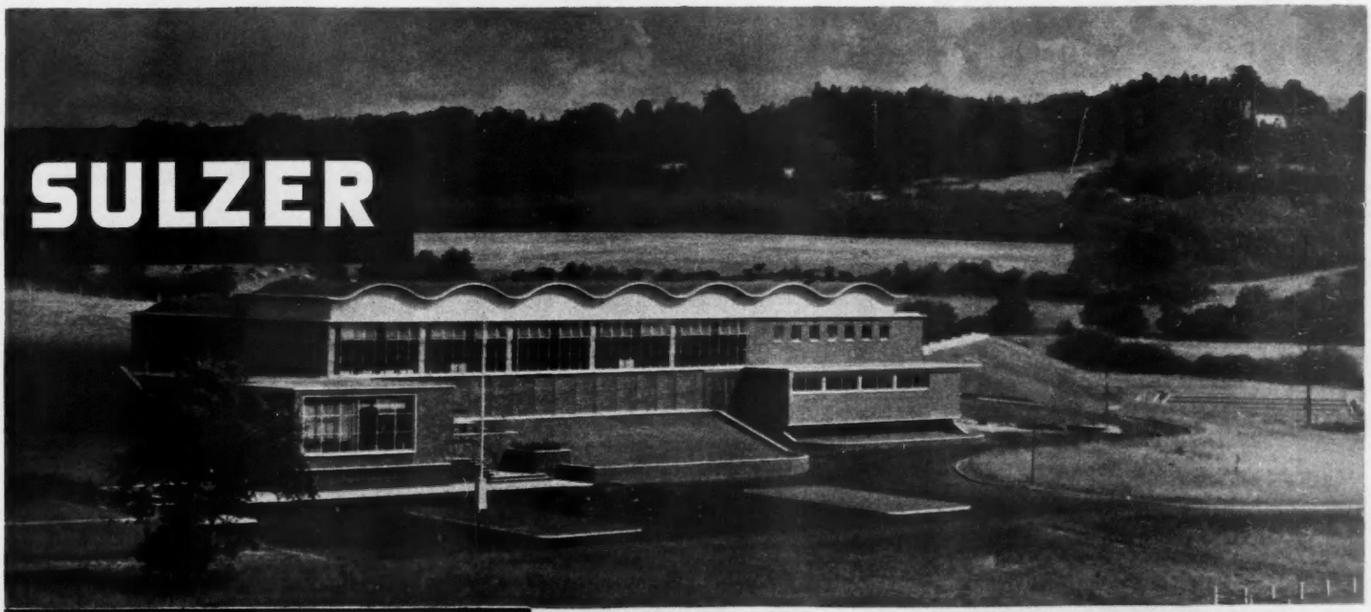

One of four multi-stage vertical pumping units each rated for an output of 78,000 gals/hr. against a total head of 296 ft.
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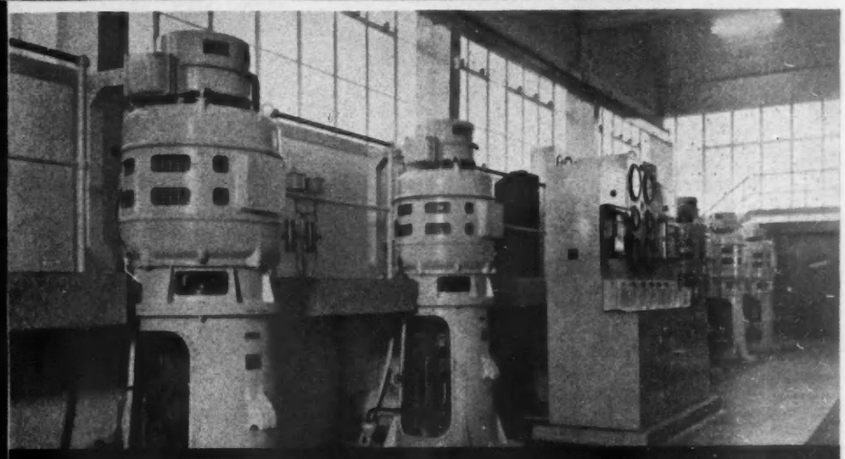

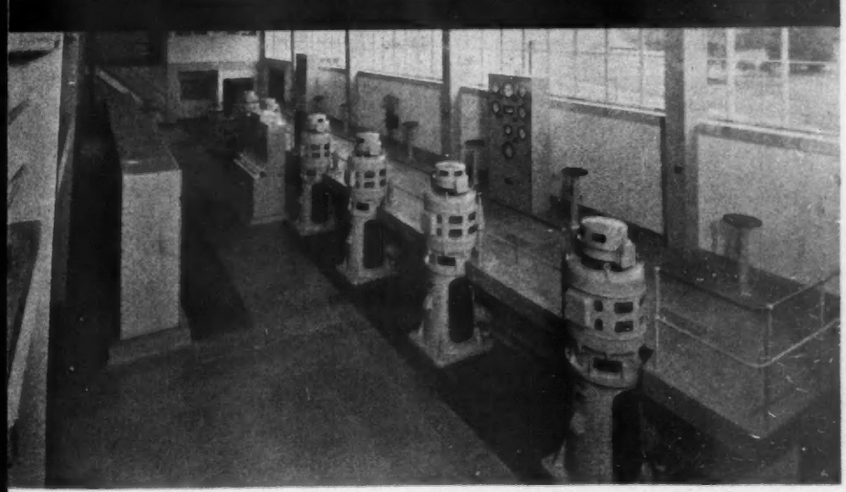

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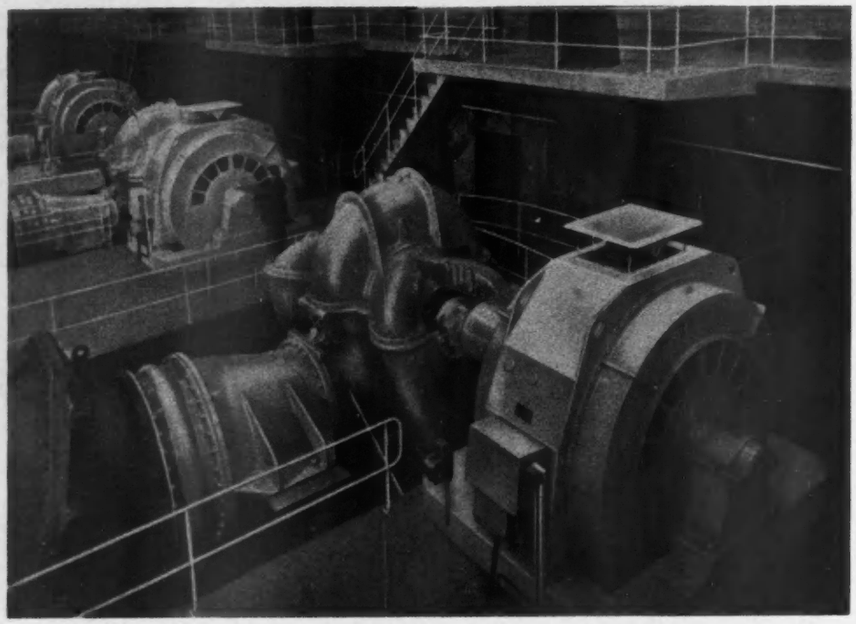

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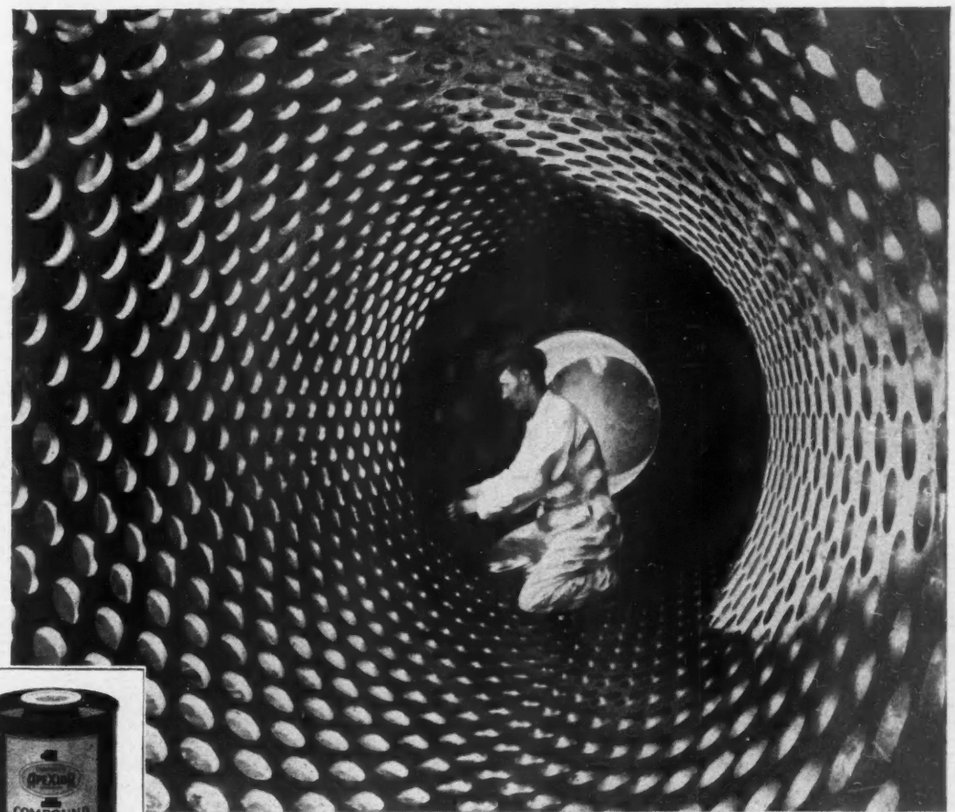

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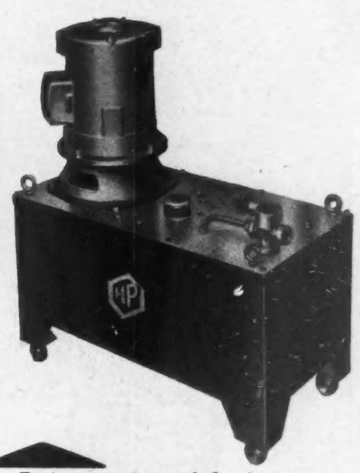

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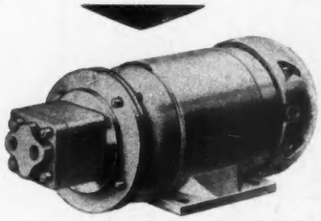

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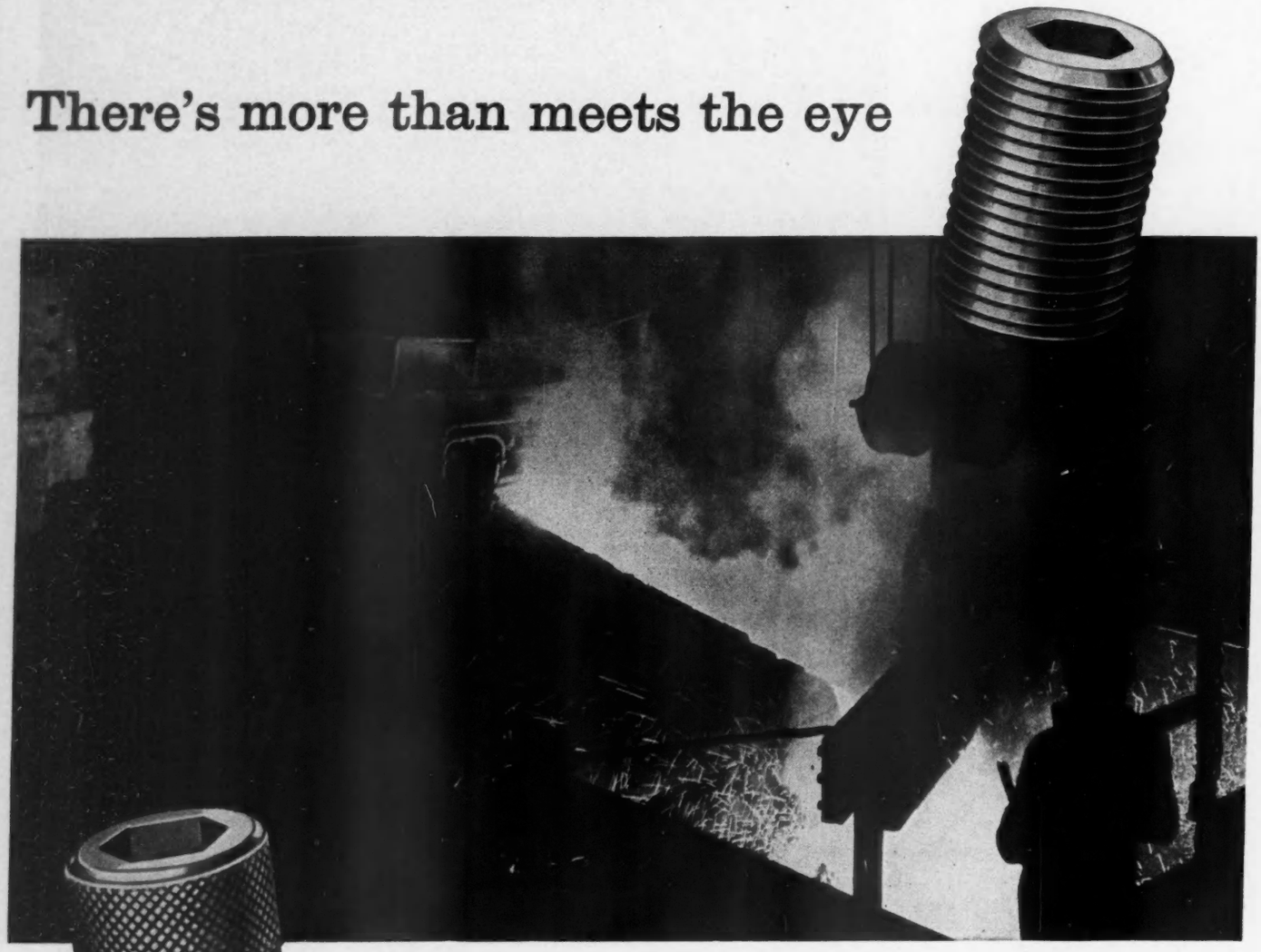

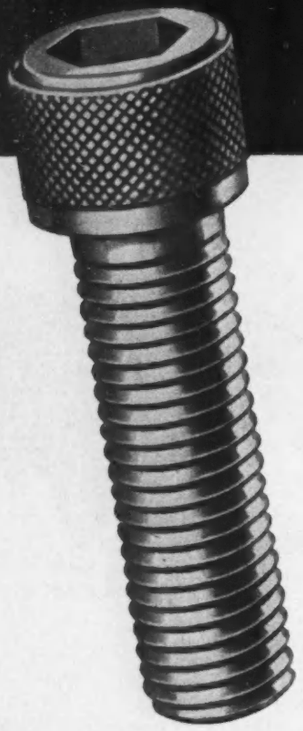

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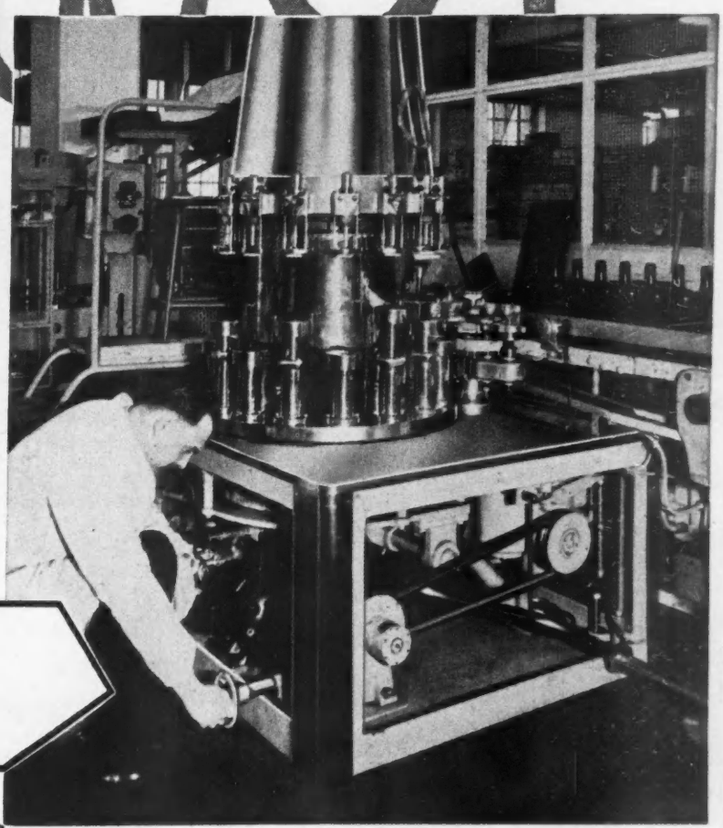

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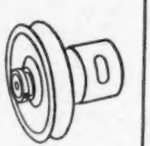

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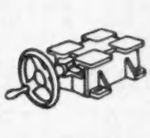

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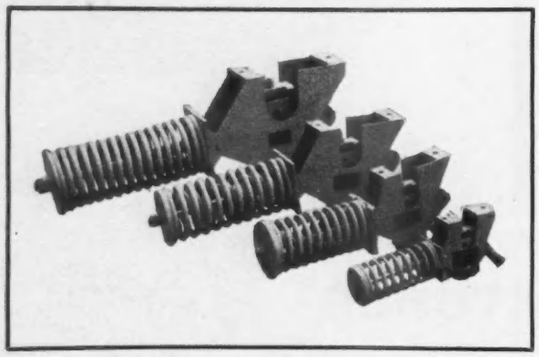

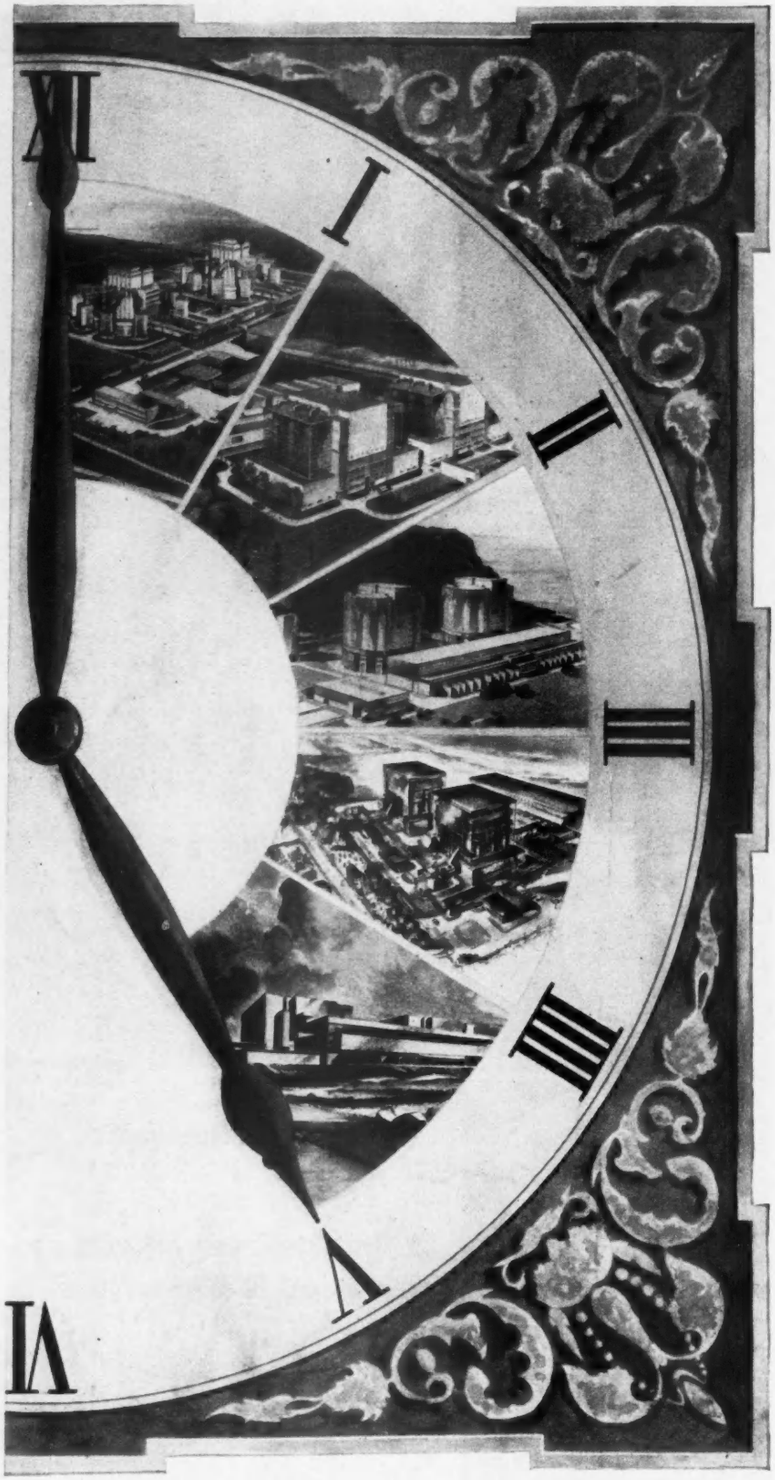

The illustrations above are artists' impressions of the Nuclear Power Stations at Berkeley (A.E.I.—John Thompson Nuclear Energy Co. Ltd.); Bradwell (The Nuclear Power Plant Company Ltd.); Hunterston (G.E.C.–Simon-Carves Group); Hinkley Point (English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group) and Trawsfynydd (Atomic Power Constructions Ltd.)

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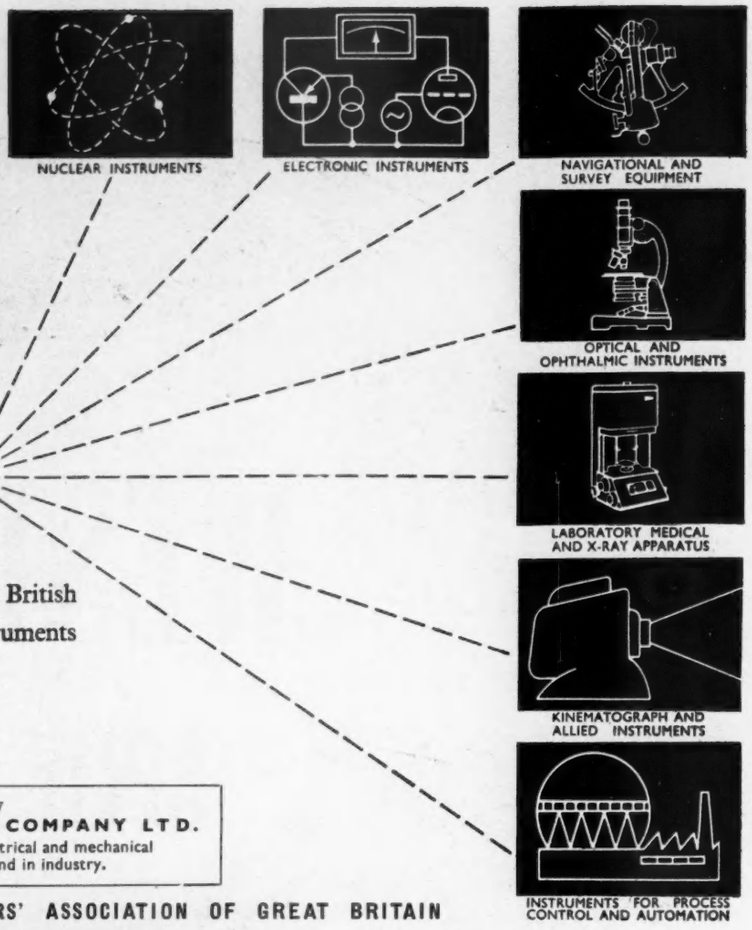

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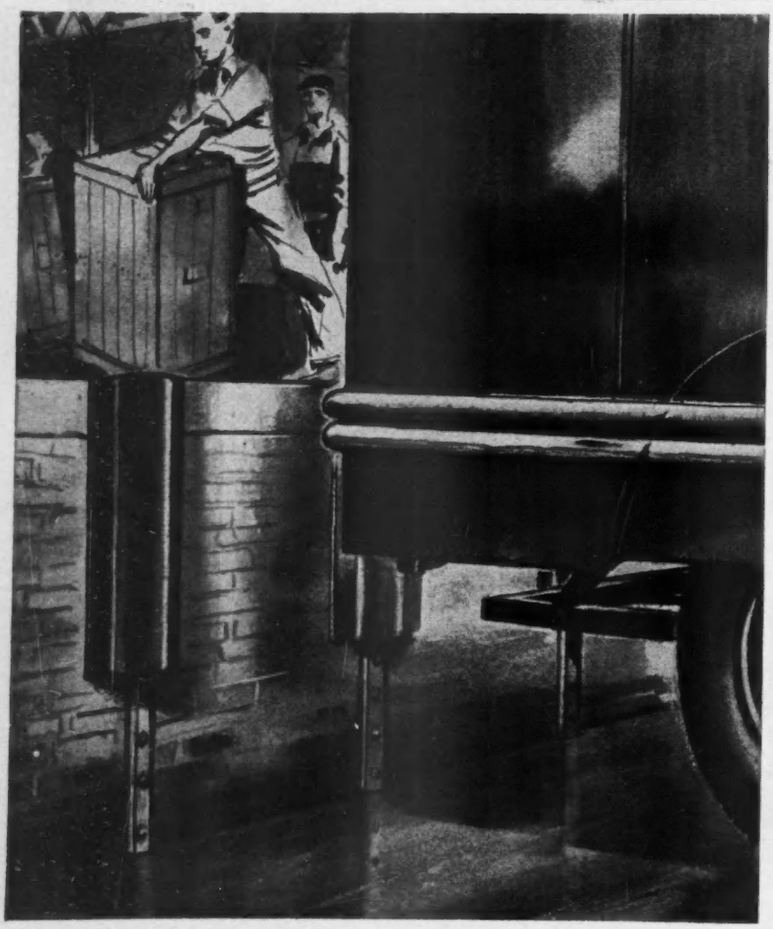

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ENGINEERING Impact

of Expanded Exports from Retarded Production

THE runaway growth in hire purchase debt of earlier this year went into reverse in May following the limited credit squeeze of April. The Board of Trade's figures for the sales trends since the second application of anti-inflation measures are not yet published but it is a reasonable assumption that they have intensified the effects of the forerunner.

From shops selling the consumer machines that were accounting for so much sheet steel and scarce labour, the volume of credit sales declined in May to an index figure of 117 (July, 1957—100). In April the figure had been up to 143.

Instead production for the home market has been checked. Manufacturers are looking to the export markets to shift those accumulated stocks and to keep capacity in use.

That this is not an expedient that can be easily taken up is evident from the current import-export figures. On Monday, 18 July, the Prime Minister is to reiterate to some 400 of the leading figures in industry and commerce the dependence of the UK on exports.

Top level pronouncements on the vital part exports play in the nation's existence are nothing new. Will there be a wind of change blowing through Mr. Macmillan's observations? The reliance on Bank Rate changes and restrictions on credit, other, that is, than the Government's, suggest not.

It is not likely that any exasperated industrialist will arise and deliver his innermost thoughts from the audience.

If one did, it might be to ask how he was to plan economically for a market that is raised and lowered with arbitrary abandon. He might also ask why deliberate difficulties placed in the way of firms over producing for the home market should be left lying in the path of firms seeking to expand for their overseas customers.

Britain Well Placed in Computer Field

Several interesting points emerged from the second annual conference of the Computer Society. This body, which was founded in 1957, now has a membership of over 2,000 and has two specialist groups, one concerned primarily with the development of equipment and its application to scientific and engineering problems generally and the other with the application of computers to business and management affairs.

Surveys of Russian and American progress revealed that the USSR admitted to being about four years behind Britain in the development of general purpose and compact machines. It seemed that the greater energy had been expended in the field of Sputniks and missiles leaving business applications rather far behind. The recently introduced system of bonus wage payments, however, was making the need for business computers felt. It was reported that by the end of an exhibition in Moscow, over 60 bodies had made application to purchase British machines.

Universities in the USA seemed to be doing surprisingly little work on computer designs. This is in sharp contrast to the position in Britain. The wave of computer buying in the USA was, like the USSR, concerned mainly with missile work. There could be a moral in this—something about getting side tracked in space.

One development that undoubtedly would ease the problems of computer operation is the introduction of a computer "language." Programming is often a long and costly business due to the need for translating the instructions into terms that the machine will understand. Some generally accepted form of basic English could increase the potential usefulness of computers enormously. The Autostat system is an example, enabling a statistician to use simple English for the instructions.

Independence for Cyprus brings New Opportunities

The Cyprus agreement means that one more territory, albeit rather a small one, can move ahead from civil disturbance and political preoccupation to the development of its resources.

For Cyprus, with the British Government providing more than £14 million in assistance and special payments in the next five years, these advances lie in a number of directions.

Existing mining activities, given capital for expansion, are well placed to provide not only for industrial employment on the island but to earn more in foreign exchange.

The Cyprus authorities have already shown signs of making a bid for part of the growing tourist trade in the Mediterranean. In a little time the terrorist activity of recent years will no more retard the holiday makers than similar memories did for Ireland.

More tourism will mean better airport facilities, better roads, more hotel accommodation. The security men have left Cyprus and in their place springs up a need for the civil engineer.

And tourists have to be fed. The British troops saw in the sloping fields of Cyprus some rather basic cultivation. There is plenty of scope here, if not for tractors and the whole galaxy of implements, at least for the smaller powered cultivators.

Cyprus has a lot to do and money to spend. It would be a pity to allow our European competitors to provide the tools and the expert assistance that the newly independent Cypriots need.

Picasso and Innocence Regained

Picasso should have been an Englishman. Perhaps the exhibition of his work now showing at the Tate Gallery will help us to recall our great experimental and acquisitive traditions.

Picasso is certainly acquisitive. From the first picture in the catalogue, painted in 1895, with the colours and command of a Velasquez, through works reminiscent of Courbet and Cezanne, to others more akin to his own contemporaries, Braque and Matisse—but adding his own unique qualities of grace, impudence, savagery or compassion—he never hesitates to borrow. One painting, "Claude and Paloma," painted in 1950, uses the colours and catches the mood of our own "kitchen sink" school. No one would deny Picasso's talent for experiment.

Perhaps a show of paintings can have little impact on the industrial climate of a nation. But fresh moods must spring from somewhere. Maybe this remarkable, precocious craftsman will prompt us to retrieve our innocence—to value once again the boyish-seeming men who are excited by experiment, who hear of other people's methods and cannot wait to try them for themselves.

of Unsettled Congo Conditions

The independent Congo, when the present troubles end, has a vital role to play in Africa. Leaving aside the political arguments what are the natural resources and industrial prospects of the new state? The Belgian Congo was the world's leading producer of industrial diamonds and cobalt. It is a major source of copper, uranium, gold and manganese. On the agricultural side it is a producer and exporter of vegetable oils, coffee, cotton and rubber. These are formidable resources.

If the Congo is to become an industrial country they must be backed up by abundant skilled manpower, capital and energy. What is the position for these ingredients for development and continued prosperity? The prospects here depend somewhat on political developments. There were around 100,000 Europeans in the Congo. Many Belgian civil servants were prepared to stay on and work for the new regime—but how many stay and for how long will depend on future stability and the working conditions.

The big question is whether there are enough responsible Africans to manage the new independent state. If there are, the necessary capital will come along. The World Bank has recently made three loans totalling $40 million, which the Belgian Government has underwritten.

Sickles into Scythes

What are the prospects on the energy front? The eastern part of the Congo produces about 400,000 tons of coal a year, but there does not seem any immediate prospect of increasing this. There is no oil but shale deposits exist south of Stanleyville and there is unexploited natural gas in Ruanda Urandi. There are big reserves of water power, so far untapped. Half the energy now used commercially comes from hydro-electric power with local coal and imported oil covering the remainder.

The Katanga province, in which most of the Congo's mineral wealth is concentrated, has around three-quarters of the country's hydro-electricity development, used mainly in ore processing. There is a scheme for a big hydro-electric power station at Inga near the mouth of the Congo River with a capacity of 400,000 kW to be in production in 1964.

The expansion of the use of oil is hampered by transport difficulties. Four-fifths of the 450,000 tons of petroleum products used each year comes in by the Congo port of Ango-Ango. The fact that the Congo is not navigable below Leopoldville has made it necessary to build pipelines. The first of these was built fifty years ago by Petrocongo, a subsidiary of the Belgian Société Générale. A 6 in pipeline, in which a number of international companies joined, was built in 1953.

Heavy transport costs to the rest of the country put up petrol and fuel oil prices outside the Leopoldville area. The prospects for the development of oil production in the Congo itself are not bright for the immediate future, although Petrocongo and Gulf Oil are undertaking off-shore drilling.

All told then, the Congo has the ingredients for development. The big questions, and they look formidable at the moment, are political ones.

and Living Standards before Prestige

In the long summer evenings of the middle of the year it is worth the effort of driving out to a country district to amble around the lanes listening to the clatter of the tractors and the wind in the overhead cables.

How easy to reflect that this is what the under-developed nations need. Dams, nuclear reactors, vast conventional stations for electric power, steelworks and motor plants for trucks and tractors.

It is also natural to enjoy the freedom from the long winter nights. Back on one such evening of last winter Sir Norman Kipping, who is director-general of the Federation of British Industries, was reflecting to the Royal Institution on the help the industrial states can give to the under-developed.

Easiest of all is the comparison, as Sir Norman pointed out, between the peasant, unchanged for five centuries, and his cousin who works not far off in the great steelworks, using a bicycle, electricity, running water, and probably reading the works magazine.

But how many of the iron and steel works of the new nations do an economical job? Egypt, said Sir Norman, was certainly turning out steel far above the cost at which it could be imported.

But national pride has its place, even though putting up the price of steel in this way is a sure brake on the pace of material advance.

The most telling point on that distant winter evening was the FBI director-general's observation that half of all the acres under cultivation in the world were still harvested with the sickle. What a great improvement simply to replace the sickle with the scythe.

This is an idea of infinite local variation. In South-East Asia the starvation conveniently known as subsistence level would be on the way out if a simple pump, able to be worked from a bicycle, could be widely handed out in order to get many times the irrigation value from the existing streams.

But handed out? The national governments need lengthy credit to set up the steelworks. The subsistence peasant suffers from a kind of absolute poverty.

Once the standards in the backward country begin to rise they can be expected to accelerate. But the problem is to start the movement toward closing the gap between the tractors and the wind in the pylons and the countries of the sickle and the wind blow dust.

New Series of High Strength Steels

A new series of ultra high strength steels for use at high temperatures has been developed by Samuel Fox.

The steels have been designed to give tensile strengths of between 100 and 140 tons per sq. in after tempering at up to 600° C. In addition to permitting higher operating temperatures to be considered in design compared with steels which are currently being specified for these strength levels, the high tempering will yield maximum stress relief and, therefore, greater dimensional stability.

There are at present three steels in the new series, of which the first is a commercial alloy already in production. This steel is well-known to give 100 tons tensile strength in the air hardened and tempered condition. Formerly described as Fox 769 it has now been renamed HST 100.

The two entirely new steels in the series have been obtained by small compositional changes in the basic HST 100 analysis, but there is no increase in the carbon content while use has been made of a combination of solution hardening and improved tempering resistance. The steels are known as HST 120 and HST 140, and have tensile strengths of 120 and 140 tons per sq. in respectively, at room temperature. It has been possible to reduce the carbon content of HST 120 to 0·30 per cent. Both these steels can be hardened in either air or in oil, depending on mass, and all three in the series have silicon contents below 0·40 per cent.

Fig. 1 shows a comparison of the tempering characteristics of the HST steels, and Fig. 2 illustrates the elevated temperature tensile properties in the range 20° to 600° C. It will be seen that, at the preferred tempering treatment of 600° C, tensile strengths of 98, 115 and 137 tons per sq. in respectively have been obtained at room temperature, combined with remarkably good ductility figures. Still higher tensile properties can be obtained, of course, by small adjustments to the tempering treatment. HST 140 has shown a 13 per cent elongation and a 41 per cent reduction of area at a strength level of 137 tons per sq. in, and it is felt that these are fairly typical figures.

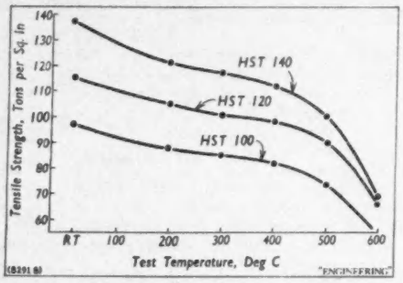


Fig. 1 Tempering characteristics of HST steel.

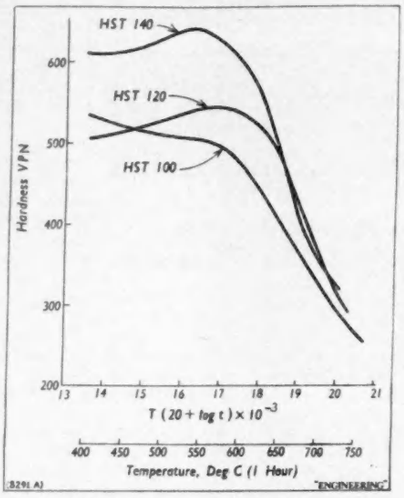
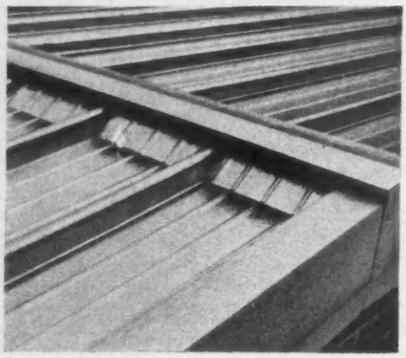


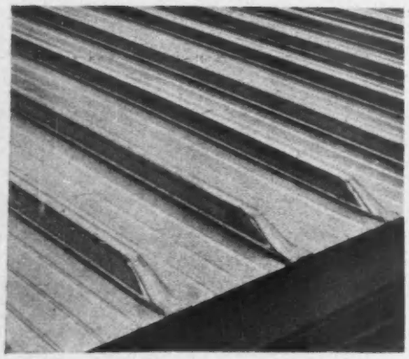
Fig. 2 Elevated temperature tensile properties. (Initial condition oil hardened and tempered 600° C for 1 hr.)

The HST steels can be produced in the form of billets, blooms and slabs for forging and re-rolling, and in bars for forging or machining. Bars can be supplied either in the annealed or fully hardened and tempered condition. Experiments are taking place to produce sheets down to 0·064 in thick in all three qualities, but these are not yet generally available.

Applications for the HST steels are expected to be found in the aircraft and rocket industries, although HST 140 could probably be used to advantage as a hot die steel.

Roofing Systems in Rolled Aluminium Sheet





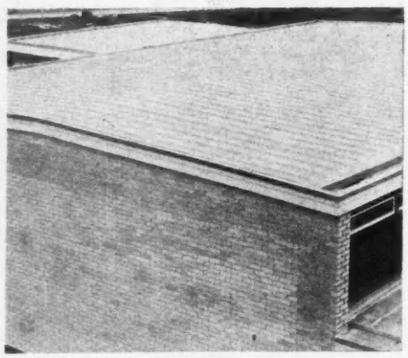
Here are two ends of Sealed-end Snaprib aluminium roofing. Above is the adjustable ridge assembly; below is the folded end of the eaves which gives "pleasing firmness and solidity."

Two new developments in aluminium roofing have been made by Northern Aluminium. These are systems based on rolled sheet sections; the first concerns treatment of eaves and ridges in the Snaprib system; the second is about the Alstrip system in which the sections are rolled on site from 18 in wide strip.

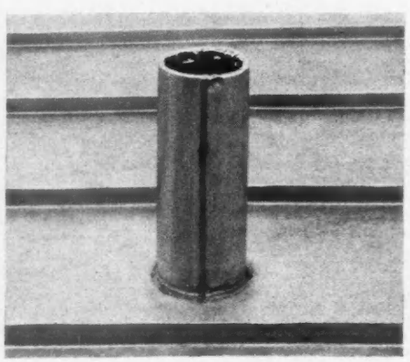
Snaprib was introduced five years ago as a system of roofing and siding with weathertightness deriving from invisible fixing; in this respect it is similar to other recent additions to the roofing range such as Lokroll, made by British Aluminium. Anyway, what's now happened is that Northern have modified the eave and ridge fitting to that shown in the illustrations; either or both ends of the sheet have been preformed to give a sealed end. The formed end is said to make installation even quicker than with the standard. Once the roof sheets have been laid a simple eaves flashing is hooked up into a slot formed by the folded end of the sheet and secured to the vertical wall; similarly a two part adjustable ridge assembly is readily and securely clipped into place on the flanges of the roof sheets.

Alstrip was introduced into this country from New Zealand by Verity and Gard'ner Limited of Northampton. The second illustrations show use of this system in the Beanfield Junior School completed a few months ago. The feature of Alstrip is that aluminium is transported to the site in coils each weighing about 450 lb (normally it is Noral 2S½H, 22 swg alloy sheet). A mobile machine forms trays directly from the strip which can stretch from gutter to gutter, secured to the adjacent one by double welting with special machines, and secured to the roof decking by special clips.

Northern Aluminium comment that "the roof needs a minimum pitch of only 2 in in 10 ft and this, coupled with the fact that uninterrupted trays up to 45 ft long can be obtained, makes it an ideal system for low-pitch gable and lean-to roofs which are becoming popular in modern architecture."



Alstrip roofing at Beanfield Junior School, Corby. Strip is formed on site and can be fitted from gutter to gutter in one run. Adjacent strips are double welted together.



Zinc-Aluminium Spray Coating

A new metal spray coating called Berkalloy has been announced by the specialists in metal and non-metal coatings—F. W. Berk.

This is a zinc-aluminium alloy in powder form for spraying with flame spraying equipment such as made by the same firm. The alloy has been evolved after many years of research to produce a coating which has what the firm call " universal corrosion properties," and certainly it combines the good properties of both zinc and aluminium.

As is well known, zinc lasts longer as a coating in alkaline conditions than aluminium whereas aluminium gives better results in acidic atmospheres. Tests over a period of eight years have shown that the Berkalloy coating gives equal protection in both conditions.

Sample plates of the alloy together with straight zinc and aluminium have been tested under severe marine conditions at North Carolina, under mild marine conditions at Frinton on Sea, in rural atmosphere at Cambridge, in mild industrial atmospheres at Greeford and in a heavy industrial atmosphere at Stratford, E15. In the latter area the plates were adjacent to plants producing sulphuric acid, and aluminium and ferric chloride.

Under these conditions a 3 mil (0·003 in) coating of Berkalloy has given excellent results (similar to aluminium) at Stratford where the zinc has failed, and has yielded results similar to zinc at North Carolina where the aluminium has failed.

While further tests will continue, the makers are satisfied that the results now available show quite clearly the value of this new coating as a protective treatment for iron and steel in all atmospheric conditions where in the past the selective use of zinc or aluminium has been necessary and in particular that in borderline cases the alloy can be used with confidence.

F. W. Berk and Company Limited, Brent Crescent, North Circular Road, London, NW10.

Inorganic Glasses Liquid at Room Temperature

A new series of inorganic glass compositions, some of which are liquid at room temperature, were recently described by Pearson and Northover of Bell Telephone Laboratories in the USA. These glasses are composed of the elements arsenic, sulphur, and bromine, and are not yet commercially available. Their preparation and properties were described at the American Ceramic Society meeting in Philadelphia.

Previous work at Bell Laboratories on compositions of arsenic, sulphur (or selenium), and thallium produced glasses which softened somewhat above room temperature, and became fluid enough to use for dip coating at temperatures between 125 and 350° C. Substitution of iodine for thallium in the sulphur compositions later produced glasses with somewhat lower softening points, with several softening below room temperature.

The new ternary compositions with bromine show even lower softening and high fluidity temperatures, with several as fluid as glycerin at room temperature. In spite of this, they are glassy solids at lower temperatures, show fractures like typical silicate glasses, and exhibit no extensive ordering in their structure.

Wide ranges of softening points and chemical compositions can be achieved. For example, substantial amounts of bromine (up to 20 per cent) can be used in the ternary mixture without dropping the softening temperature. With the addition of greater amounts, softening and high fluidity temperatures decrease to room temperature and below.

Outside the area of glass formation in the phase diagram, crystalline materials are formed, or else the compositions precipitate sulphur. However, within a large area of composition variation, glasses show no tendency toward instability over extended periods of time.

The new compositions appear to show the same characteristics as the previously reported low melting glasses. They are relatively stable toward acids, but are attacked by alkalies. They tend to hydrolise in water, with this tendency increasing in compounds showing lower softening points. The solids show good bulk resistivities, with values as high as 10^{15} ohm-cm. The resistivities of the liquid compositions are not as high, lying around 10^{8} ohm-cm.

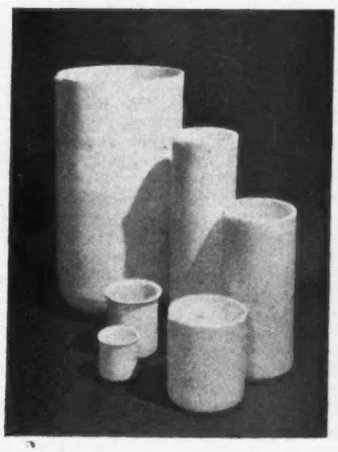
Another interesting aspect of the new glasses lies in their optical transmission properties. They are all transparent, ranging in colour from ruby red to light amber. The indexes of refraction appear to range between 1·9 and 2·0, which is comparatively high for glasses.

Preparative techniques are relatively simple. The measured amounts of the constituents are weighed into a quartz tube with a pulled down neck. The contents are then frozen in liquid nitrogen, the tube evacuated and sealed off. These sealed tubes or ampules are then encased in a simple pipe-bomb, and heated in an oven at about 400° C for three to four hours. Simple agitation is sufficient to bring about reaction in the cases where glass formation occurs. The rate of cooling to room temperature does not appear to be critical.

Bell Telephone Laboratories, 463 West Street, New York 14, USA.

Ptfe Beakers

Because of its unique resistance to chemical attack and corrosion, ptfe has many applications in the chemical processing industry. Latest



ptfe product of the Fluorocarbons Department of AEI Radio and Electronic Components Division, is a range of beakers.

These are available in the range of standard sizes (with internal diameter from 1·6 to 7½ in and depth 2·0 to 15 in) but can also be supplied to customers' specifications with an appropriate tool charge.

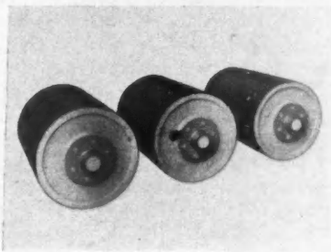
Associated Electrical Industries Limited, 155 Charing Cross Road, London, WC2.

Rollers Coated with Pvc

Ducking rollers used in the pickling of continuous steel strip can now be fully protected against chemical corrosion. This latest development by Tanks and Linings is the result of several years' research into the possibility of providing a roller with a plasticised pvc outer skin, and was made in close association with one of the leading stainless steel producers.

The rollers are constructed almost entirely from rigid pvc and there are no metallic parts whatsoever in contact with the pickling liquid. The stub shaft ends run in carbon and ptfe bearings, but a variety of end conditions can be provided.

Because the stainless steel strip must be completely immersed in a bath of nitric-hydrofluoric acid, it is essential that the ducking roller is fully resistant as well as being mechanically strong.



Pvc has been found not to pick up and retain metal particles that could mark or scratch high quality strip.

Tanks and Linings Limited, Town Wharf, Droitwich, Worcester.

Semi-Conductor Materials

Following their announcement on 1 March of this year that they will be in production of ultra-pure silicon by the end of 1960, Monsanto Chemicals are now able to supply development quantities of intermetallic semi-conductor materials produced by Monsanto in the USA.

Monocrystalline indium arsenide and polycrystalline indium phosphide are already available, and additional materials, including single and doped crystals, will be available shortly.

These materials, like ultra-pure silicon, are of interest in development of new semi-conductor devices for the electronics and electrical industries.

Monsanto Chemicals Limited, 10-18 Victoria Street, London, SW1.

Rubber Based Zinc Coating

A new liquid zinc anti-corrosive composition for use on iron and steel and other metal surfaces, has been developed by the MacCleaster Chemical Company.

The preparation has a base of chlorinated rubber and zinc dust of extremely small particle size, and among the important advantages claimed for it is freedom from rapid settling out. In the past, the combination of chlorinated rubber and zinc or other metals has created certain problems, one of which has been the rapid settling out of the composition or paint. The MacCleaster preparation requires no more than normal stirring before use.

It can be applied by brush or spraying or by dipping, over rusted surfaces or even over surfaces which have been previously painted, subject only to some scraping or wire brushing. It is also of above average flexibility, is abrasion resistant and although not specifically heat resistant, will withstand a dry temperature of 200° C and a wet temperature of 120° C. It posses excellent fire retardant properties, prevents " rust creep," and is impervious to polluted atomsphere and to sea and fresh water.

The manufacturers claim that the composition is equally efficient as a single coat system or as a primer, giving increased adhesive properties to the top decorative finish, making it particularly suitable in the protection of structural steelwork and for general industrial use. Its cathodic properties are especially important for marine application and since the dried film is non-toxic it can be used for the protection of water tanks and cisterns.

MacCleaster Chemical Company Limited, 8 Great Tower Street, London, EC3.

Plain Words

By Capricorn

I KNOW it is easy to quibble over words. Words mean different things in different contexts, and it is a sobering thought that if we were to define our terms with the strict mathematical preciseness favoured by pedants we should limit ourselves severely in the things that we could say. Our communication potential would be cut to a fraction. Possibly we should be incapable of saying anything new, anything not already implied in the definitions. But in their very flexibility and comprehensiveness, words can dominate or deceive. The word I am about to put on trial—well aware that I am not the first—is "automation." The future of production engineering may well depend on how it is interpreted.

On the whole automation is a good word, at least a useful one, and conveys a reasonably clear meaning to most people. What I presume they understand by it is the use of machines instead of human beings for tasks involving some discrimination. I myself look upon it rather as the application of control engineering to production processes. Only a word so conveniently vague could convey such disparate ideas. But under its aegis march two lines of technical development which in object are diametrically opposed.

On the one hand, the production of identical components in enormous numbers requires the application of control engineering to ensure the steady automatic flow of items through a continuous process. Human handling and disposal are replaced by automatic transfer. On the other hand, there is the use of control engineering for producing small numbers of widely differing components, as in the Ferranti and EMI electronically controlled milling machines. Here human setting up is replaced by automatic data processing.

One-off production, mass production—both embraced by automation. A harmless association, one might be led to think. Unfortunately, we tend to accept a notion all or nothing. And, if for some reason we throw out the more familiar large-scale possibilities of automation, then out goes the baby with the bathwater—a baby Britain needs. It is the small-scale aspect of automation that we tend to overlook.

If Britain persists in staying outside the Common Market then we may never operate on a sufficient scale to justify general automation. Even for a transfer press, the break-even point as against single-blow presses is estimated to be about a million items. Integrated flow lines may seldom suit our situation, but to reject other production applications of control engineering on this account would be disastrous.

Bearing in mind our traditions of skill and quality, cheap but accurate small-number production may prove to be our lifeblood. Some forms of automation, therefore, we should be foolish to neglect.

Letters to the Editor

Bonus Schemes Need Work Study

SIR, One suspects that Mr. R. J. B. Stein, in his article entitled "Borus Schemes are Not What They Seem" (ENGNG., 17 June '60, p. 822), has set out to be provocative; he has certainly succeeded and I would like to ask your indulgence to put forward other points of view on the general question of bonus schemes with particular reference to the so-called non-repetitive or jobbing work.

For instance, Mr. Stein says "a simple bonus scheme might work in this way" and then proceeds to describe one which, in my submission, will never work successfully so as to constitute a fair deal for both management and men, without bringing in its train all the evils catalogued in the rest of the article under review.

Granted that the designing and planning stages can be satisfactorily disposed of, the real kernel in the job is defining the correct method of doing the job followed by determination of the time necessary to carry out the task at a defined standard of performance by a qualified worker. In other words, it is submitted that the only way to operate a bonus scheme successfully is to embody in it the principles of work study in relation to both methods and work measurement.

There is a world of difference in estimation by a rate fixer and patient method and time study by a work-study investigator and there is the same difference also in the results obtained by each. It is appreciated that the determination of work unit values using the techniques of work study is more expensive than the normal method of the rate fixer and it also involves the controversial question of rating the operator for skill and effort. The time established for a job in this way, however, is at any rate based on the best method and incorporates proper allowances for relaxation and contingencies and is thus far less liable to be the subject of contention between management and men.

The determination of times for jobs over a wide range of work can be recorded and used for later setting up of allowed or standard times by using the techniques and analytical estimating or synthesis from elemental data. These latter techniques are particularly useful in jobbing work since, although such work is frequently described as being non-repetitive, there are, in fact, a great number of common elements in all such work and, once a variety has been measured by formal and accurate timing, it is amazing how data so obtained can be used for the rapid calculation of times for doing similar jobs, but differing considerably in detail.

The calculation of the operator's wages when working under a bonus incentive scheme need not present any difficulty if a normal operator performance corresponding to a time rate of pay has been established by work-study methods. For performances above normal, his reward can be based on a straight line curve which will terminate at some performance above standard and thus reward him in direct proportion to the extra effort which he is prepared to give. Such a system removes the grave moral objection mentioned by Mr. Stein in making too high a proportion of the weekly take-home pay dependent upon performance.

Mr. Stein says that "the psychological effects of a bonus system are far reaching." They are. But if a scheme, properly constructed according to the principles of work study, is applied by people who understand how to handle staff by acquainting them fully with the details of the scheme in advance, the effect on the industrial climate is usually good. There need not be any personal jealousy among operators if there is a proper method of acquainting them of the amount of their bonus earnings week by week.

Another point made by Mr. Stein is that it should be the object of rate fixing to ensure that there are no "good" jobs and no "bad" jobs. The value of a work study scheme, employing as it does the concept of rating for skill and effort and an evaluation of all the factors attending a given job, is that it ensures that the time established for the job is the correct one.

If the contention that the most serious practical disadvantage of the bonus scheme is its tendency to produce shoddy work is correct, then there is something wrong with management. There are many reliable methods of sampling for inspection which will ensure that the quality of work is maintained.

A final word: A good bonus scheme based on work study principles does not tend to place some of the responsibility on the shoulders of the operators. The very fact that management has studied in detail the requirements for performing a good job in the best possible way which can be devised at that time, cannot but reveal management deficiencies, which are brought to light at the proper time; that is, before the job is started and not when it is half completed.

Yours Faithfully,
W. G. F. THORLEY.

1 Carlyon Close, Alperton,
Wembley, Middlesex.

1 July, 1960.

Hydraulics at the Universities

SIR, We have read with interest the article entitled "Hydraulics Departments for Universities?" by Dr. R. Silvester (ENGNG., 22 April '60, p. 546). Substituting "fluid mechanics" for "hydraulics" we think that no one will dispute the importance of the subject in the engineering industry and in the training of engineers.

In the universities of this country, this importance has to a large extent been recognised. In addition to the chair at Imperial College, there is a chair in aeronautics and fluid mechanics at Glasgow University and there are chairs in fluid mechanics at Manchester and Liverpool Universities. Other universities have strong fluid mechanics groups which are in many cases incorporated into departments of aeronautical engineering.

There is no doubt that the subject of fluid mechanics is becoming of greatly increased importance in many fields of engineering as well as in aeronautics. For instance, in chemical engineering and in nuclear power engineering, fundamental knowledge of turbulent mixing processes is urgently required for the solution of heat and mass transfer problems, and the economical pumping and accurate metering of a variety of fluids is assuming great importance.

It is highly disputable whether Departments of Fluid Mechanics, as such, should be entirely responsible for all the teaching and research in fluid mechanics and have the stature of a major department. The subject of fluid mechanics is not like that of, say, electrical engineering, which has well defined boundaries. The applications of fluid mechanics are intimately connected with other important aspects of engineering. For instance, aerodynamic problems arising in the design of aircraft, missiles and engines cannot be considered independently of the structural, mechanical and control aspects. Similarly in the application of hydraulics to civil engineering and water power engineering, the fluid mechanics cannot be isolated. These applications are generally highly specialised and the only common ground is in the fundamentals of the subject.

At Liverpool, the Department of Fluid Mechanics gives a basic course of instruction common to all engineers for the first year and a more advanced second year course for mechanical and electrical engineers. For the final year, we provide two courses for mechanical engineers: one for those who, in after life, do not intend to make the subject their main interest, and a more intensive course for honours students who intend to take a greater interest in the subject and perhaps enter the aircraft field.

In addition to these courses given by the Fluid Mechanics Department, the Mechanical Engineering Department provides courses in the aerodynamics of turbo machinery, heat transfer and gas dynamics. The second year and final year civil engineering students have their own specialised courses in hydraulics. Thus, the Department of Fluid Mechanics provides the basic teaching in the subject and carries out fundamental research, but other departments are responsible for the specialised applications. In this way, we think there is the greatest freedom for the fundamental and applied aspects of the subject to develop along lines best suited to their needs.

If we turn to the research in the subject which is carried out by Government establishments we see that even here there is no centralised institute for fluid mechanics, but that there is a variety of establishments dealing with fundamental and applied aspects of the subject according to the particular needs of industry and the Services. There may be overlap in some researches but there is also much more independent thinking than would be possible in one vast organisation and the needs of the users are undoubtedly better met.

Yours sincerely,
J. H. PRESTON,
Professor of Fluid Mechanics.
J. H. HORLOCK,
Professor of Mechanical Engineering.
Walker and Harrison-Hughes
Engineering Laboratories,
The University, Liverpool.
6 July, 1960.

After Education—Training

SIR, It was interesting to see your long and serious review of Dr. Kate Liepmann's thought-provoking book entitled *Apprenticeship: An Enquiry into Its Adequacy under Modern Conditions* (ENGNG., 8 July '60, p. 58). This book raises important issues far beyond the mere training of the craftsmen of the future.

Trade unions, for example, discuss the limitation of apprenticeships to estimated numbers of craftsmen needed in the near future. While this may be valid in some trades the skilled man with some real training is a better man in many ways, whether he continues in the same trade or not; and some kind of real training is the birthright of every school leaver.

Employers, for example, are always moaning about the shortage of skilled labour, or of competent professional engineers. What have they done in the past to improve things, observing that improvement in these matters lies almost entirely in the hands of industry?

Professional institutions, and educational establishments, for example, are much too wedded to one of the curses of the age—the pigeon-holing of people into categories—engineers, craftsmen, draughtsmen, technicians, technologists, and so on. They seem to forget that the greater includes the less, and that the engineer must have a background training in all phases, if only so that he may play his part in industry in training his own draughtsmen and assistants.

Another recent book on the same subject, by Professor Lady Williams, raises thoughts of the weakness of our attitudes to educational and training systems at all levels. It has been well said that "No man can form a really sound judgment on an activity in which he has not in the past himself taken some part." Our present emphasis on training for administration and management, for example, pursued to its logical conclusion as the most important high level activity, soon leads to a state where we have nothing of our own left worth managing.

Our present dependence on foreign designs and methods tends to confirm the impressions derived from these two books: the old master-apprentice relationship is dying out, and what survives is being crushed between the upper and the nether millstones of the short-term vested interests of the employers' federations and the trade unions.

Yours faithfully,
HUGH CLAUSEN.
17 Harman Drive,
London, NW3.
8 July, 1960.

Events in Advance

Industrial Applications of Aviation Electronics

MUCH interest is being taken at present in the developments in electronics which have occurred in the British aircraft industry and it is considered in many quarters that a large number of these developments could be of value over a much wider field, and especially to the manufacturing and process industries.

In order to provide a means of exploring these developments from this aspect, the South Western Section of the British Institution of Radio Engineers are organising a short convention at the Bristol College of Science and Technology on Friday and Saturday, 7 and 8 October, next. Prominent members of the manufacturing and process industries are being invited to detail their existing difficulties in the electronics field and it is expected that a number of helpful papers and discussions will result. A small exhibition is being arranged in connection with the convention and both functions will be open to all interested persons.

The address of the British Institution of Radio Engineers is 9 Bedford Square, London, WC1 (telephone MUSeum 1901), but application forms and further information may also be obtained from the honorary secretary, South Western Section, British Institution of Radio Engineers, c/o The School of Management Studies, Unity Street, Bristol 1.

Exhibitions and Conferences

Plastics in Industry Exhibition.—Fri., 15 July, to Fri., 29 July, in the Exhibition Pavilion. Park of Kirov, Leningrad. Organised by the Plastics Division, Imperial Chemical Industries Ltd., Millbank, London, SW1. Tel. VICtoria 4444.

Plasma Physics, International Summer Course.—Mon., 1 Aug., to Fri., 12 Aug., at the DAEC's Research Establishment, Risö. Apply to Danish Atomic Energy Commission, Research Establishment, Risö, Roskilde, Denmark.

Geographical Union, International; 10th General Assembly and 19th International Congress.—Sat., 6th Aug., to Sat., 13 Aug., in Stockholm. Apply to the assistant secretary, Geographical Association, Park Branch Library, Duke Street, Sheffield 2.

Radiation Biology, Third Australasian Conference.—Mon., 15 Aug., to Thurs., 18 Aug., at the University of Sydney. Apply to Dr. Peter Ilbery, Department of Preventive Medicine, The University, Sydney, NSW, Australia.

Crystallography, Fifth General Assembly of the International Union of.—Mon., 15 Aug., to Sat., 20 Aug., in Cambridge, at the joint invitation of the University of Cambridge and the Royal Society. Followed by symposia from Mon., 22 Aug., to Wed., 24 Aug., on "Thermal Motion in Crystals and Molecules" and "Lattice Defects and the Mechanical Properties of Solids." Apply to Dr. W. H. Taylor, Crystallographic Laboratory, Cavendish Laboratory, Cambridge.

Geological Congress, 21st International.—Mon., 15 Aug., to Thurs., 25 Aug., at the Mineralogical-Geophysical Museum, The University, Copenhagen. The congress is being organised jointly by Denmark, Finland, Iceland, Norway and Sweden. Apply to the general secretary, International Geological Congress, Mineralogisk Museum, Øster Voldgrade, Copenhagen K, Denmark.

Geography (Physical and Cultural), Course in Practical Field Techniques.—Wed., 17 Aug., to Wed., 31 Aug., in South Devon, under auspices of the Geographical Association. Apply to the assistant secretary, Geographical Association, Park Branch Library, Duke Street, Sheffield 2.

Chemistry (Pure and Applied), 17th International Congress on.—Fri., 26 Aug., to Mon., 29 Aug., in Munich. Apply to the secretary-general of the International Union of Pure and Applied Chemistry, Dr. R. Morf, c/o Sandoz, SA, Basle, Switzerland.

Histochemistry and Cytochemistry, First International Congress of.—Sun., 28 Aug., to Sat., 3 Sept., in Paris. Organised under the auspices of the Société Française d'Histochimie in collaboration with histochemical societies in many countries. Apply to Dr. R. Wegmann, 45 Rue des Saints-Pères, Paris, 6e.

Electron Microscopy, European Regional Conference.—Sun., 28 Aug., to Sat., 3 Sept., at Delft. Organised by the Nederlandse Vereniging voor Electronenmicroscopie and held under the auspices of the International Federation of Electron Microscope Societies. Apply to A. L. Houwink, secretariat of the European Regional Conference on Electron Microscopy, Julianalaan 67A, Delft, Netherlands.

Combustion, Eighth International Symposium.—Mon., 29 Aug., to Fri., 2 Sept., at the California Institute of Technology. Apply to the Office of Industrial Associates, California Institute of Technology, Pasadena, Calif., USA.

Semiconductor Physics, International Conference.—Mon., 29 Aug., to Fri., 2 Sept., in Prague. Organised by the Czechoslovak Academy of Science and held under the auspices of the International Union of Pure and Applied Physics. Apply to Dr. Miloš Matyáš, Institute of Technical Physics, Cakrovarmická, Prague 5, Czechoslovakia.

Forest Congress, Fifth World.—Mon., 29 Aug., to Fri., 16 Sept., in Seattle, Washington, USA. Apply to Dean Hardy L. Shirley, State University College of Forestry, Syracuse University, Syracuse 10, NY, USA.

Leipzig Autumn Fair.—Sun., 4 Sept., to Sun., 11 Sept., at Leipzig. Consumer goods. Organised under the auspices of the Chamber of Foreign Trade of the German Democratic Republic, 40 Unter den Linden, Berlin, W8. Fair offices: Postschliessfach 329, Leipzig C1, Germany. Agents: Leipzig Fair Agency, 39 St. James's Place, London, SW1. Tel. HYDe Park 3111.

Electrons in Aviation and Their Industrial Applications, Convention and Exhibition.—Fri. and Sat., 7 and 8 Oct., at the Bristol School of Science and Technology. Organised by the South Western Section, British Institution of Radio Engineers, c/o the School of Management Studies, Unity Street, Bristol 1. Institution offices: 9 Bedford Square, London, WC1. Tel. MUSeum 1901.

Office Management Conference and Exposition.—Mon., 10 Oct., to Wed., 12 Oct., at the Atlanta Biltmore Hotel, Atlanta, Ga., USA. Organised by the National Office Management Association. Apply to the Field Service Division, NOMA, 1927 Old York Road, Willow Grove, Penn., USA.

Synthetic Rubber Symposium and Exhibition, Second International.—Tues., 11 Oct., to Thurs., 13 Oct., at Church House, Great Smith Street, London, SW1. Organised by *Rubber and Plastics Age*, Gaywood House, Great Peter Street, London, SW1. Tel. ABBey 7447.

Youth Conference on the Atom, Second Annual National.—Thurs., 20 Oct., to Fri., 22 Oct., in Chicago.

Power and Mechanical Engineering, 24th National Exposition (National Power Show).—Mon., 28 Nov., to Fri., 2 Dec., at the Coliseum, New York. Organised by the International Exposition Co., 480 Lexington Avenue, New York 17, USA.

Commonwealth Mining and Metallurgical Congress, Seventh.—Four weeks from Mon., 10 April, to Sat., 6 May, 1961, will be spent in Union of South Africa; and two weeks, from Sun., 7 May, to Sun., 21 May, 1961, in Northern and Southern Rhodesia. Apply to the congress manager, Seventh Commonwealth Congress, PO Box 809, Johannesburg, South Africa.

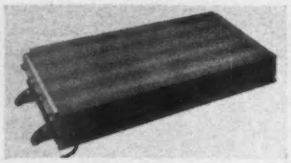
Higher Management, Course for.—Mon., 8 May, to Fri., 19 May, 1961; and Mon., 29 May, to Fri., 2 June, 1961, at Dunford College, near Midhurst, Sussex. Inquiries should be made to offices of Associated Industrial Consultants Ltd., or to the AIC College of Management, 54-58 Uxbridge Road, London, W8. Tel. EALing 4567.

British Trade Fair.—Fri., 19 May, to Sun., 4 June, 1961, at Sokolniki Park, Moscow. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Construction Equipment Exhibition.—June, 1961, at the Crystal Palace, London, SE19. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

MAGNETIC CHUCK

Impulse Energised



THE latest addition to the Eclipse range of magnetic chucks is designed for pulse energisation.

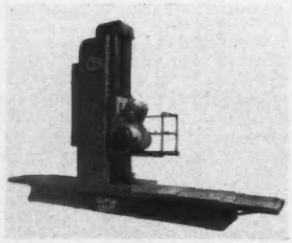
It is particularly claimed that this allows a higher magnetism to be used as the flux field is then at its full value of remanent magnetism. The chuck is built up from a series of Alcomax magnets below soft steel pole pieces. Round the magnets are magnetising and demagnetising copper coils set in waterproof jelly. A fabricated case of high permeability mild steel is used to give rigidity and reliability while the top plate is made up of laminations providing longitudinal poles and gaps with graded reluctance.

When it is desired to clamp a workpiece in position, a button mounted in a separate remote control unit is pushed which passes a high current through the coils saturating the magnets completely. An automatic timing device in the circuit cuts off the current after a few seconds so that the coils can be overrun during the magnetising period. This means that smaller sizes can be used than would be the case for continuous rating. Moreover, current consumption is reduced as current only flows during the magnetising and demagnetising operations. Demagnetising is carried out by reversing the flow of current through the coils allowing the work to be removed without effort. Operation is fully automatic, both actions being initiated by push button.

The intense field allows rough workpieces to be held safely, and since current is only required at beginning and end there is no risk of damage from mains failure during machining. Some 16 chuck sizes are available ranging from 24 in by 12 in to 40 in by 20 in, as well as complete control equipment including oiltight push buttons. *James Neill and Company (Sheffield) Limited, Napier Street, Sheffield 11.*

MILLING MACHINE

Girder End Facing



A NEW girder end facing milling machine has a cutter 3½ in diameter using tungsten carbide tools.

The cutter is mounted direct on the end of the main motor which is integral with the saddle. A lateral adjustment of 4 in is provided by a hand lever through gearing and with a micrometer index. A 3 h.p. two speed reversing motor operates the vertical motion. Horizontal traverse is by a 5 h.p. motor, also of the two-speed reversing type, through gearing; the screw being held in tension in the traverse bed for both directions of motion. A platform for the operator moves with the column. The narrow guide principle is used.

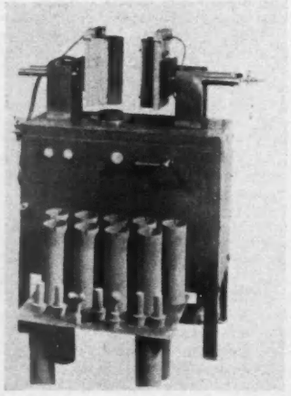
Two rates of vertical and horizontal feed are provided, giving traverses of 30 in per minute and 60 in per minute. Variations can be obtained by the use of interchangeable pulleys. All slideways and gearing are lubricated and there are telescopic guards over the beds.

A pedestal mounted control station has push buttons for the 30 h.p. main motor with a pneumatic timing delay in the starter. A single joystick four position controller is fitted for the longitudinal and the vertical traverse motors and a lever operated selector switch is used for fast and slow feeds. There are limit switches for the vertical and horizontal traverses.

The standard machines accommodates surfaces up to 6 ft high by 10 ft 6 in long, but can be modified to take larger areas. The main motor spindle is bored No. 50 morse taper. Cutter and arbor are rigidly held in the spindle by means of a draw bolt. *Clifton and Baird Limited, Empress Works, Johnstone, Scotland.*

SHELL CORE BLOWER

180 Per Hour



A NEW machine for producing shell cores from resin sands will perform up to 180 blows per hour.

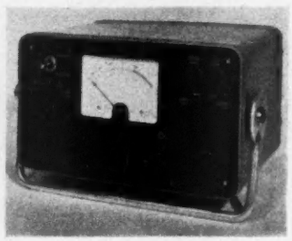
After closing the core box and raising the sand chamber to seal the corebox entry, the cores are blown. The air is then exhausted from the chamber, the chamber lowered and the box opened for the removal of the cores. The operations are performed in sequence with a single six-position control lever. A pneumatic vibrator operated by a push button empties sand from the cured shells. An automatic air blower nozzle and hose is fitted for clearing residual sand.

The machine has an overall height of 4 ft. The cabinet is 3 ft wide, 1 ft 6 in deep, and 3 ft 1 high. Various sizes of plates and heaters can be fitted. The standard sand chamber, which is mounted under the bedplate, has a capacity of 35 lb but larger ones can be supplied. An attachment is available to enable three part boxes to be used.

The height of the two machined heads that carry the core boxes can be adjusted and also the gap between them. Mounted on the heads are the heated plates to which the halves of the core box are attached. The left hand plate is fixed and the other is moved by a heavy duty pneumatic cylinder. *Foundry and Metallurgical Equipment Company Limited, Queens Road, Weybridge, Surrey.*

FOUR CHANNEL MIXER-AMPLIFIER

Transistorised



THE four channel mixer amplifier BD956 has been designed for use in the field in any climate.

The use of transistors has made a very light unit which, including supply unit and battery weighs less than 15 lb. There are four low level inputs suitable for microphones or transcription heads, switchable for inputs of either 30 or 600 ohms. There is one high level input and two alternative output lines, one of which can be used as a cue line. Output impedance is 75 ohms balanced or unbalanced. The faders have moulded carbon tracks for noise-free operation without maintenance and there is provision for monitoring of both output lines by meter and headphones.

The consumption is 3 VA from a power supply of 200-250 V 50 cycles. Ten Mallory battery cells form an emergency supply with a drain of 100 mA. The mains supply is routed to a transformer whose output is rectified by a bridge rectifier to 12 V. The battery is automatically brought into use in the event of mains failure. Terminals are included for an external battery.

The maximum input level thar can be applied on the low range is ±40 dbm and on the high range +20 dbm. Maximum output level is +20 dbm into 600 ohms. From the low level the maximum gain is 90 db, and from the high level 10 db. Frequency response is ±1 db from 30 cycles to 15 kc/s. Harmonic distortion is less than 1 per cent RMS at maximum output. The noise output is less than −25 dbm at maximum gain. The case measures 12 in high by 6 in wide by 9 in deep. *Marconi's Wireless Telegraph Company Limited, Marconi House, Chelmsford, Essex.*

SQUARING SHEARS

Air or Foot Operated

ADDITIONS to the Keetona range of shears are available for foot or air operation.

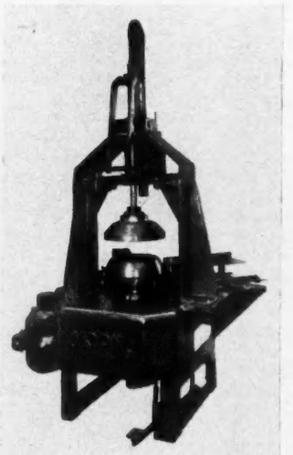
There are two sizes of each with widths of 40 or 50 in. The treadle machine will cut up to 18 gauge but the air operation has power for 16 gauge. Hand operated hold down is used on both. The front gauge brackets are graduated up to 24 in and the back gauge is adjustable up to 22 in. There is a chute for delivering sheared material to the rear of the machine.

Fabricated steel construction is used throughout making the machines virtually unbreakable. Four edged blades are fitted. The whole of the cutting line is visible during the action and there is a finger guard for safety. The treadle of the foot operated machine extends the full length, and the foot switch for the air operated version can be positioned to suit the operator. Air at 70 to 80 lb per sq. in is required for working the machine to capacity but the demands are small, only 15 cu. ft per minute of free air being consumed when working at a rate of 30 strokes per minute. An air vitaliser is incorporated.

Large diameter springs make the action of the treadle machine quite easy and roller bearings on the slides allow the work to be handled without undue fatigue. The air-operated machine is totally enclosed. A 5 in diameter air cylinder replaces the whole of the electric motor and drive units. *Keeton Sons and Company Limited, Keetona Works, Greenland Road, Sheffield 9.*

TRIMMER AND BEADER

For Hollow Ware



A SEMI-AUTOMATIC machine has been introduced to replace spinning lathes for trimming and beading large diameter metal pressings.

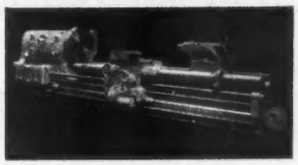
The design is basically a horizontal deck with a vertical overhead clamp to hold the pressing. There is an automatic clutch for starting and stopping and there are two independant cam controlled tool posts carried on very robust slides. With suitable tooling all combinations of flange trimming; square trimming; curling and beading; rilling and flanging; and double seaming can be carried out.

All components are readily adjustable and change cams can be provided to control the movements of the tool posts. The machine uses a 5 h.p. motor running at 960 or 200 r.p.m. Overall dimensions are 53 in long by 70 in wide by 99 in high.

Speed of operation has been achieved to reduce time in the manufacture of sheet metal bowl shaped pressings and spinnings with a complete cycle time of 3·2 or 6 seconds. The machine will handle a range of sizes from 12 in to 28 in in diameter. *Moon Brothers Limited, Beaufort Road, Birkenhead.*

CENTRE LATHE

32 in Swing



MODEL BV32 is a new centre lathe with a 32 in swing and admitting 10 ft between centres.

A main feature of the design is that the headstock provides 36 spindle speeds from 5 to 800 r.p.m. split into 24 forward geared speeds (with helical final drive to the spindle) from 5 to 400 r.p.m. in a progressive ratio of 1 to 1·2, and a further 12 speeds from 100 to 800 r.p.m. by belt drive to the spindle (with final gearing disengaged) for finish and ceramic turning. There are 12 reverse speeds in ranges from 13·5 to 35 and from 135 to 350 r.p.m. obtained from the gear drive, and six reverse speeds are also available from the belt drive.

The spindle is bored to pass 5 in diameter and can have either a 14¼ in fixing flange or American taper nose. The spindle bearings for the front housing comprise a pair of dual purpose angular contact ball bearings matched with a roller journal bearing, all being preloaded for thrust.

The totally enclosed feed gearbox provides 48 rates of feed in ranges of 0·002 to 0·1 in per revolution for turning and boring, and from 0·001 to 0·05 in per revolution for facing. Screws can be cut from 1 to 56 threads per in. An alternative output ratio selected by a lever provides for coarse screw cutting up to 8 in lead, metric pitches being obtained by a transposing gear.

The saddle has an inverted V guide from the bed and the cross slide is fitted with a recirculating ball screw assembly. The tool post is power operated for a travel of 11 in; will swivel through 360°; and carries a hardened square turret indexing in eight positions. The apron incorporates feed reverse mechanism and an overload device, and has lever control of the headstock driving clutch. *Denham's Engineering Company Limited, Empire Works, Halifax.*

SHOVEL LOADER

7,000 lb Capacity

NOW available in this country is the Allis Chalmers TL16 D Tracto-Loader.

The machine has a carrying capacity of 7,000 lb and a lifting capacity of 17,000 lb. It is available with buckets from 1½ to 4 cu. yd capacity. Power is provided by a 104 h.p. engine giving three speeds both forward and reverse, with a top speed of 27 m.p.h. Power shift is used with hydraulic clutches. The single lever allows changing into and out of gear while the loader is moving. There is power steering and four wheel power brakes which can be operated by the right or left foot.

The drive is to all four wheelsw ith a power shift transmission and a 3·5 to 1 single stage torque converter. Large planetary axles are used. The axles are pinjointed to the frame with 2 in diameter steel pins to eliminate rolling and shifting under load and the warping of mounting plates and bolts. The rear steering axle has an oscillation of 20° for negotiating rough ground.

The breakout force that can be exerted is 20,500 lb at the cutting edge of the bucket, which has a 40° tip back angle at ground level and 45° at the carry position. Dumping height is 9 ft from the cutting edge of a 2 cu. yd bucket with a 3 ft reach. Straight line linkage is used to give maximum power. Overall dimensions are 17 ft 6 in long with the bucket in the carry position, 7 ft 6 in wide, and ground clearance of 1 ft 3 in. The weight is 18,000 lb. Tyres front and rear are 14·00 by 24 12 ply, and track front and rear is 5 ft 10½ in. *Mackay Industrial Equipment Limited, Central Way, Feltham, Middlesex.*

BLAST CLEANER

Portable, Self-Contained

A COMPLETELY self-contained portable blast cleaner now on the market is notable for its small size.

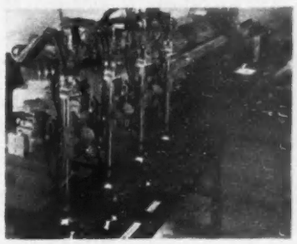
The Educt-o-Matic weighs 7 lb and contains its own vacuum pickup and dust extraction unit, so that all that is needed for operation is an airline. Air at 90 to 100 lb per sq. in is required, the consumption being from 33 to 60 cu. ft per minute.

The abrasive is continuoulsy circulated so that there is little waste. A full charge of 4 lb will normally blast for 15 to 40 minutes according to the skill of the operator, which need not be great. Most common abrasive powders can be used: steel shot or grit, aluminium oxide, silicon carbide, or walnut shells. A screen size of 40 mesh or finer is recommended.

Compressed air sucks the abrasive from its container through a venturi nozzle which spreads the blast evenly over the area enclosed by the rubber boot. This gives a blast pattern of 1 in to 1½ in diameter. Boots are available for flat or large diameter surfaces, for cleaning edges, shapes and the insides of 90° angles. A vacuum picks up the abrasive with the material blasted off and passes them to a small cyclone for separation and then to a dust bag. *Hodge Clemco Limited, Victor Engineering Works, New Road, Rainham, Essex.*

PROFILE CUTTER

Drawing Template



A FEATURE of three new Oxweld dual carriage shape cutting machines, Series CM 56, is the roller drive that enables the drive-wheel to be clear of the template.

The machines use a photocell head to trace the outline of a drawing made to the exact size of the finished part. A built-in adjustment allows for the metal cut by the torches so that reproduced parts are the same size as the drawings. A compensator dial allows for plates up to ¼ in thick.

Preheat gases and cutting oxygen are controlled by solenoid operated valves large enough for multi-torch operation. Each torch has an individual solenoid valve for instantaneous cut-off, eliminating over run at the end of a cut. All valves are controlled by switches from a panel. Each torch also has fine adjustment valves for gas and oxygen.

The three models carry four, six and eight torches respectively but others can be added within the limits of the beam. Motorised torch holders provide automatic up and down adjustment and an automatic height adjustment control is also available. This rides the plate in front of the torches to take account of any irregularities.

Tracing accuracy is claimed to be within 0·005 in and the tracer can negotiate 90° turns with $\frac{1}{16}$ in radius at speeds up to 16 in per minute and ½ in radius at 27 in per minute.

Either the main or transverse carriage can be locked so that it is possible to produce perfectly straight lines either parallel or at right angles to the main rails. *Union Carbide International Company, 30 East 42nd Street, New York 17, NY, USA.*

ENGRAVING MACHINE

Three Dimensional Work

THE Scripta 3D is a bench copying and engraving machine of French make, which has a knuckle joint in the pantograph allowing it to carry out three dimensional work.

The pantograph is adjustable for ratios between ½ and ⅛ in 23 steps. At one-half the coverage of the pantograph is 120 mm by 240 mm (4¾ in by 9½ in approximately), and the size of the work table is 240 by 260 mm. The template table measures the same. The spindle speeds are infinitely variable from 3,000 to 16,000 r.p.m.

Master pieces of any shape can be used and it is also possible to produce masters in the machine with an enlarging attachment that is virtually an inversion of the motor unit and the stylus. A feature of the machine is the large area that can be covered for small overall dimensions. The machine measures 900 mm long (35·5 in) by 550 mm wide (21·6 in) by 800 mm high (31·4 in). It weighs approximately 195 lb.

The worktable is adjustable for height and position, being fixed by a hand clamp. The template table can also be adjusted to suit the model. T-slots are provided for fixing. The pantograph head is mounted on a robust column with vertical adjustment by handwheel and lead screw. Moulds can be cut without removing them from the machine and a range of five cutters of 3, 4, 5, 6, and 8 mm diameter is available. *Acbars Limited, Cecil House, 57a Holborn Viaduct, London, EC1.*

HAND GRINDER

300,000 r.p.m.

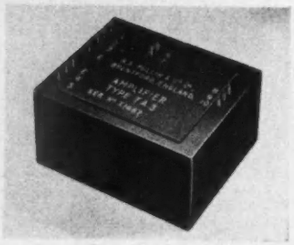
DEVELOPED from the field of dentistry, the Ashcombe Airotor revolves at 300,000 r.p.m.

The tool can be used for most grinding and engraving purposes either held in the hand or in the clamp of a machine. One example is in a pantograph engraving machine. Carbide burrs are used and materials up to 62 Rockwell C can be machined.

The Airotor itself is only ⅛ in diameter and ½ in long, the remainder being the handle. With a carbide burr in the chuck the overall length can be kept to 1 in so that it can be used in confined spaces. The handle can be in line as illustrated or at right angles, the change taking a matter of seconds. Air at 40 lb per sq. in is used with a consumption of 2 cu. ft per minute. All the moving parts are contained in a replaceable cartridge. A control unit available includes two filters and a pressure regulator. Lubrication is by injected fog. *W. J. Meddings Limited, Ipswich Road, Trading Estate, Slough, Buckinghamshire.*

SERVO AMPLIFIER

Transistor Operated



THE TA3 is a transistor operated servo amplifier, providing a maximum power output of 6 watts over a temperature range from $-40°$ C to $+65°$ C.

The unit is designed to give the control phase power for a range of servo motors and motor generators. Extending the temperature range to $+70°$ C, the output falls to 4 watts, both figures being for free air with no heat sink. The amplifier is intended for input supplies of 13-0-13 volts 400 cycles but can also be operated from 18 volts d.c. The input impedance of the amplifier is approximately 3 kilohms in series with a 2μF coupling capacitor. By varying the connections the unit can be used in a feed back system in conjunction with external resistors.

The amplifier is constructed of material generally in accordance with DEF 5,000 to meet Service requirements. It consists of an assembly containing the components moulded in a block of silica-loaded resin. Heat conduction is effected through the base plate, and extra cooling can be obtained by mounting the unit on a metal plate or chassis. Connections are easily accessible for soldering.

The sensitivity of the unit is such that 4 watts output can be obtained for not more than 150 millivolts input. The frequency range is from 150 cycles to 3 kilocycles for a loss of 3 db when operating on d.c. supplies. An alternative input connection gives an impedance of 25 kilohms also with a 2 μF coupling capacitor. Overall dimensions are $2\frac{3}{4}$ in by $2\frac{1}{4}$ in by $1\frac{1}{8}$ in including spills, and the weight is 14·6 oz. For mounting there are four 4BA tapped holes in the base plate. *R. B. Pullin and Company Limited, Phoenix House, Great West Road, Brentford, Middlesex.*

SELF-TRIMMING GRAB

For Railway Wagons

IT is claimed for a new unloading grab that it will clean out a steel railway wagon of 14 tons of slack in from 15 to 18 " bites."

The jaws are designed so that when fully open the digging edge is vertical and the width is that of the wagon. On lowering, the jaws slide down the inside of the wagon sides and clean out the coal completely. Owing to the receding radius of the jaws the grab tends to pull itself into the stock so that it digs throughout the closing stroke and lifts a full load every time. The jaws are geared together to give consistent smooth closing.

The jaws are bevelled and hard faced and it is unnecessary to crash the grab into the stock; it will load under its own weight. Capacities range from $\frac{1}{2}$ to 3 cu. yd and types include light, medium and heavy weight mode's to suit the various materials it may be required to handle. On a site two $1\frac{1}{2}$ cu. yd grabs are regularly unloading 140 tons of small coal per hour.

Alloy steel link and trunnion pins are used in conjunction with hardened steel bushes. The pins are flush with the bucket face and are lubricated through high pressure grease nipples. The hardened steel pulleys run on roller bearings and are quickly released for reeving up or alteration of ratio. Ratios of 2, 4 or 5 to 1 are available. The rope anchors are the wedge and socket type. *Michael and Partners Limited, 99 Saltergate, Chesterfield.*

SUPPORT STAND

For Cylindrical Components

THE " B " block is designed to replace the standard V block for supporting cylindrical components.

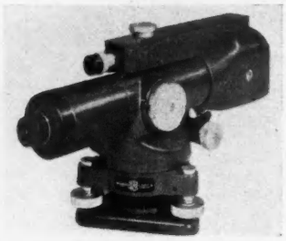
It is claimed that the B block is more accurate and will accommodate a wider range of parts than a V block. It is not so liable to mark and an accuracy of $\pm$ 0·0001 in is achieved at commercial prices. Only two surfaces have to be accurately machined.

The stand consists of four hardened and polished steel balls locked together on a flat surface. The balls are self locating by virtue of their own accuracy and the component thus becomes self aligning by providing four contact points on each block. The four point support minimises the chances of " making even " when the component is being revolved. For a very heavy load accurately made shims are available for spreading the load, and for very soft metals balls of nylon can be fitted. As each pair of balls is unequally spaced two different angles are provided. Should wear occur the balls can be unlocked and rotated.

The same pair of B blocks will accommodate diameters from $\frac{1}{4}$ in to 10 in and clamps are made for holding components vertically. Flat plates can be supported. *Rubert and Company Limited, Accru Works, Demmings Road, Councillor Lane, Cheadle, Cheshire.*

LEVEL

Automatic Aligning



A FEATURE of the Autoset level is that it will maintain a level line of sight even when the telescope is tilted.

Setting up the instrument is simple: all measurements are made from a datum formed by the horizontal line of sight and it is only necessary to centre the bubble. Vertical displacements within a range of 0·5 in can be read direct to 0·001 in from a glass scale in the eyepiece of the optical micrometer.

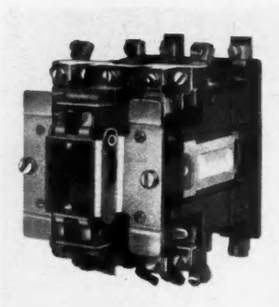
The level has a telescope that rotates in a horizontal plane, an optical reading micrometer fitted to the end of the telescope, a circular bubble unit, and a three-screw levelling base.

The self levelling device consists of a fixed prism giving an erect image located above two swinging prisms supported by metal tapes. When the telescope is tilted the suspended prisms move to maintain the line of sight level. Repetition accuracy is better than 1 second of arc and oscillation of the prisms is eliminated by an air damped piston which also limits the swing to $\pm$ 20 minutes.

The focusing range of the level is from 6 ft to infinity. The body of the telescope is dust and moisture proof. Magnification is 32, the aperture $1\frac{3}{8}$ in and the field of view 1° 20′. Subdivisions on the micrometer scale are 0·001 in which is also its overall accuracy. Pointing accuracy is to within 1 second and the sensitivity of the circular bubble is 8 minutes per mm. The weight is $8\frac{3}{4}$ lb. Accessories include a mounting plate, cast iron instrument stand and wooden tripods; and a rectangular glass target with three sighting marks at 0·5 in intervals. *Hilger and Watts Limited, 98 St. Pancras Way, London, NW1.*

CONTACTOR UNIT

Air Break Type



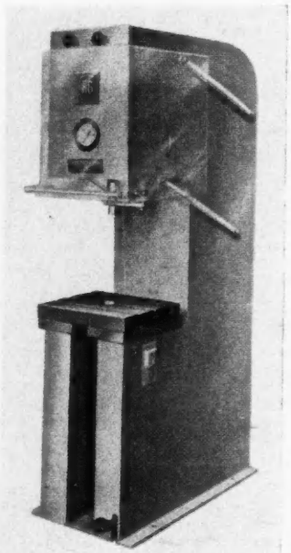
A NEW range of contactors, the type UAC, has been introduced particularly for applications requiring a number of contactors and relays in a single enclosure.

Three sizes are made with ratings of 15, 25 and 50A, for one, two, or three phase supplies up to 550V. They are triple poled and arranged for front of board mounting. By slackening two spring loaded clips the entire magnet assembly can be withdrawn for inspection and maintenance. The magnet system is alternating current operated, of the three limb self-aligning pattern with horizontal movement. The fixed core and moving armature are made from high permeability laminations. The operating coil is normally connected between phases but can be arranged for phase to neutral operation if desired. Alternatively it can be energised from a separate supply.

The vertical double break arrangement of the contacts prevents accumulation of dust. Both main and auxiliary contacts are easily removable and all mating surfaces are of silver. The 25A size has steel cooling plates and the 50A unit has glass-mica arc boxes with splitter plates to improve performance. A maximum of four auxiliary contacts can be provided, either normally open or normally closed. They can be changed over on site as required. Mechanical interlocks can be fitted. *Allen West and Company Limited, Brighton 7.*

HYDRAULIC PRESS

High Speed Operation



THREE models make up a new range of hydraulic presses for general work.

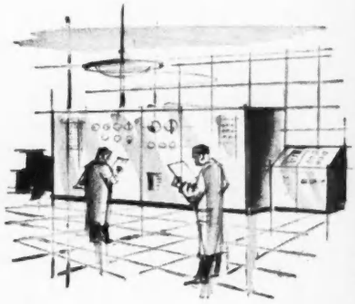
The R-G presses have capacities of 5, 10 and 15 tons, the smallest being made as either a bench or pedestal mounting model. The 15 ton version is illustrated. On all three models there is control of the operating pressure and slow ram advance by a regulator close to the pressure gauge. Both ram nose and table are designed to take most forms of tooling.

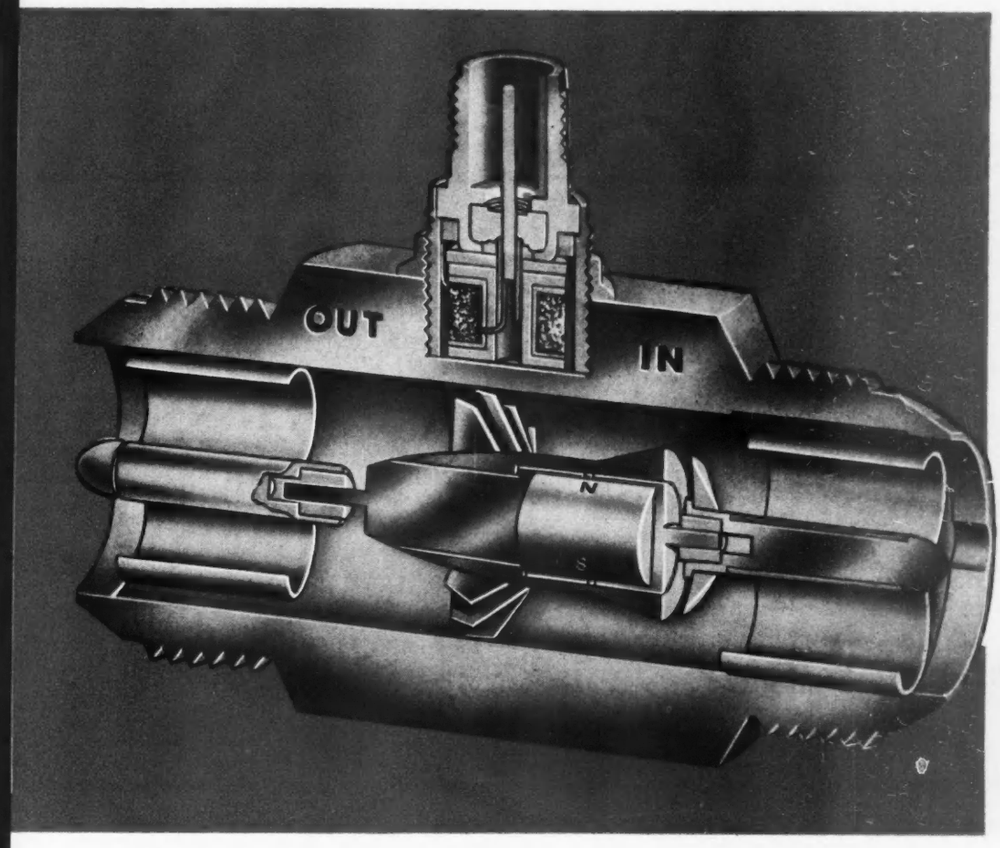
Both the 10 and 15 ton models work on the jack ram prefill system. The down stroke can be limited by a knurled wheel at the side of the press, which also allows inching. On the 5 ton model an accumulator system provides rapid ram approach with instantaneous speed reduction and the application of full pressure as soon as contact is made. The double acting cylinder provides positive ram return. Strokes for the three models are 4 in, 8 in and 10 in. *Dowding and Doll Limited, 346 Kensington High Street, London, W14.*

Wherever information on fluid flow is required,

the de Havilland POTTERMETER

sets new standards of accuracy and reliability





This new turbine-type flowmeter enables major advances to be made in the techniques of flow measurement and control. The de Havilland Pottermeter is the only flowmeter which offers all these features:

- **Accuracy to ±0·1% or better on repetition work, ±0·5% or better over a 20·1 range. Calibration remains constant for a variety of liquids over wide flow ranges.**
- Contains only one moving part—no thrust bearings—operates with a minimum of maintenance at high temperatures and pressures.
- No larger than the pipeline in which it is installed—may be mounted in any attitude.
- Can be supplied with indicating, recording and process control equipment—gives digital presentation of results.
- Can measure volumetric or mass flows.
- Models available to measure flows from 0·1 to 40,000 Imperial gallons per minute, at a wide range of operating pressures. Larger and smaller sizes made to order.
- Can measure flow of any liquid or gas, irrespective of its lubricating or non-lubricating properties, at temperatures ranging from -455°F to 1500°F.
- Manufactured as standard in stainless steel—can be made in any non-magnetic material.
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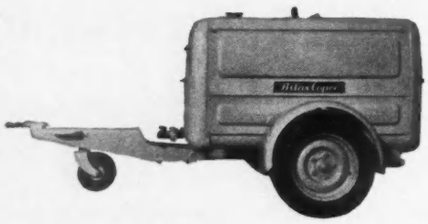

Weight 2,180 lb (990 kg) ★ 115 c.f.m. 3.2m³/m

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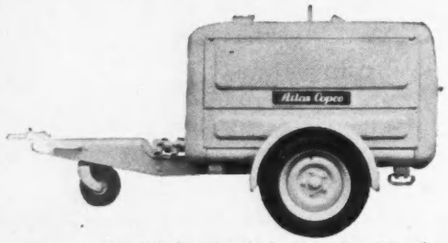
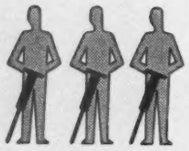


Weight 2,310 lb (1,050 kg) ★ 160 c.f.m. 4.5m³/m



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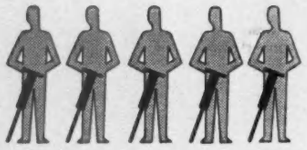

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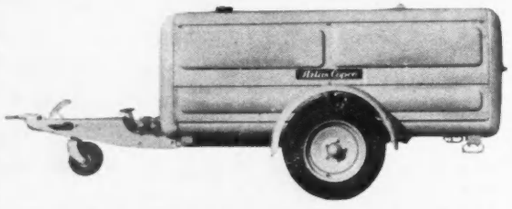
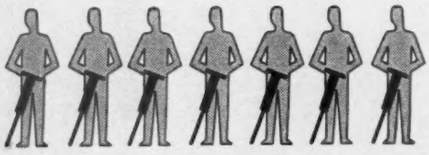


Weight 3,590 lb (1,630 kg) ★ 315 c.f.m. 8.9m³/m



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P-G 11

Human Element

Skefko Apprentices in European Tests

APPRENTICES of the Skefko Ball Bearing Company, Luton, took part in the general fitting, turning, milling, precision fitting and patternmaking sections of this year's Bemetel tests.

Following the test work of 3,000 European apprentices, the Dutch training organisation was last month showing 2,000 test pieces at the Hague.

Skefko were the only British company submitting test pieces this year. Mr. J. B. Brown, the company's training officer, told ENGINEERING that in turning and fitting his boys' standards had improved over last year. Three of the apprentices reached the test standard in turning but were failed for taking too long.

One of the most significant details of the tests conducted by Bemetal—"the Netherlands foundation for industrial training in the metal and electrotechnical industry"—was the time allowed for the very precise work required.

In turning and fitting, working to tolerances unusually small even for some United Kingdom tool rooms, the apprentices were expected to complete the test piece in 38 hours. Training staff in this country have described these speeds as beyond all but the best of British tool room workers.

The majority of Dutch apprentices finished their test pieces in between 38 to 42 hours although two were able to finish the job in just short of 30 hours.

In the opinion of Mr. Brown, the Skefko training officer, the Dutch apprentices were maintaining their very high work standards and retaining their speed. One of his own entrants was awarded the Bemetal diploma in patternmaking.

Britain has nothing like the Bemetal organisation, a body on which large, medium and small firms and the trade unions are represented. Its 48 technical inspectors, who visit every member firm at least once a month, have the duty not only of promoting training in the metal industries but of supervising the instruction of apprentices. There are 75 divisions of industry for whom the good influence of Bemetal is active, ranging from the Royal Dutch Airlines (KLM), the Netherland Railways, shipyards and iron and steel foundries to textiles, paper mills, public utilities and small, sub-contracting general engineering shops.

At the centre of Bemetel's influence on the high metal working standards of its members' workers is the *standaardvakeisen*, the standard requirement for particular operations laid down from the mass of experience accumulated by the consultant technical inspectors.

From these standards the Bemetal organisation draws up its twice yearly examinations for apprentices. This year Swedish and Italian apprentices were taking part, working at set times to drawings sent from the Hague, as in the case of Skefko. For the Swedish and Italian apprentices the assessing was being carried out in their own countries.

The influence of competitive apprenticeship upon the standards of workmanship is obviously profound. The attitude to his job of an apprentice who has no final examination to prepare for is likely to be at a lower level than that of the boy who sees that his work is taken seriously by experts. And who knows that a successful apprenticeship will give him a qualification bearing on his status in work and his pay.

At the Skefko works at Luton, Geoffrey Bexson, one of the apprentices whose test piece was being submitted to the Hague, told ENGINEERING's representative: "Working for this test is definitely encouraging. It helps you to work with greater enthusiasm and speed. Doing it in the time allowed is a problem but we enjoy having a crack at it."

Fresh Scheme for Metallurgy Diplomas

New arrangements for courses leading to the Higher National Diploma in Metallurgy have been made by the Ministry of Education and the leading professional bodies.

Under the revised scheme diplomas will be awarded on the results of a three-year sandwich course or a two-year course for students who have had full time education up to the age of 18 (including among their subjects, chemistry, physics and mathematics), or those who, while in full time work, have reached Ordinary National Certificate standards in chemistry, physics and mathematics.

The organisations with whom the Ministry cooperated in working out the scheme were the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of Metals and the Institution of Metallurgists.

The full details are set out in the Ministry pamphlet *Arrangements and Conditions for the Award of National Certificates and Diplomas in Metallurgy (Rules 111)*, HMSO, 6*d*.

Battle Lines for the Coal Industry

It is a common experience when reading the history of wars to discover that their causes and even the way in which the opening campaigns were to develop were laid down years in advance of the first shots.

Is something like this happening in the coal industry?

The struggle for a national wage structure for mining is one of the classics of labour history. If the miners are a distrustful and canny people this has as much to do with it as the ever present dangers of their occupation.

Now Mr. Robens says he is personally in favour of decentralisation. This explains a puzzling episode. When the news of his appointment leaked out Mr. Robens could be heard protesting that he was very keen on public ownership of the coal industry. This was rather like saying that he was all in favour of defeating the Kaiser.

The real question to be answered is whether one coal field is to sell against others or not. Decentralisation does not necessarily mean that they will.

A quick glance at the economics of the coalfields makes it plain enough that if they did the demand for some Scottish and Northern England output would sharply decline.

The descent into area wages and social disaster for some mining areas is plainly feared to be an inevitable consequence by some of the miners' leaders. At their annual conference at Llandudno the National Union of Mineworkers put it beyond doubt that they believe the present structure of the coal industry is correct and where changes are needed, they should be made within the present framework.

Consultation and a general taking into the Board's confidence before important decisions are made is not exactly encouraged by the veiled threats at Llandudno to take industrial action against decentralisation.

There are lessons to be learned here from the marketing practices of the European Coal and Steel Community.

Some 65 per cent of the United Kingdom's coal is sold within the area of the regional board's in which it is mined. That could mean that competition in price could be allowed for coal within its own area though not beyond the mining board's boundaries.

Even this is certain of opposition on the grounds that the industrial and domestic users of a dear coal area are not going to be long in claiming the benefits of the cheap coal enjoyed by their neighbours.

The Encouraging Employer and Further Training

Far and away the most important single finding of the second volume of the Report of the Central Advisory Council for Education (England), otherwise known as Crowther Part Two, is that the percentage of apprentices who obtain their Ordinary National Certificate is almost twice as high from firms who encourage their boys as for the general run of firms.

This second volume is made up of the surveys which helped in the preparation of the first part of the report. The technical courses survey is accompanied by the social survey and that into National Service.

It is a long standing belief that unrelieved part-time education is discredited. Its disadvantages are an unsatisfactory breadth of learning, and a too severe cramping of the individual subjected to such rigours.

The man who put forward the proposal that British industry had more skill than it knew what to do with, would at the very least damage his reputation for common sense. Yet the present system of imparting technical knowledge leading to the various National Certificates is evidently about as incompetent as it possibly could be.

One in four of those who enrol with a National Certificate course get through to the Ordinary level. Only about one in ten reaches the Higher level, more or less pass degree. And, while the great majority who fall out do so in the first year, they do not all do so after failing a qualifying stage. One quarter of those who leave do so after qualifying in the last stage they attended.

This is evidence that outside influences are more responsible for the decision than level of achievement on the course. It is shown, again, that the boy with day release has considerable advantages, though he has his difficulties.

More than one conclusion can be reached from the discovery that the boy starting with a sound General Certificate of Education appears the most likely to succeed. He may have obtained the good qualification because of natural aptitude which happens not to have been creamed off towards the university.

Or he may do better on the course because his work for the GCE has prepared him for the long discipline of achieving Higher National by study "in his own time."

That the boys with this better preparation can get through in better numbers than the low overall average represents a challenge. What is wanted is that more efficient incentives and more sympathetic aid and encouragement shall be brought to bear in the crucial early months of the individual's further technical education.

Reforming the Power Ministry's Advisory Body

The revised form of the Ministry of Power's scientific advisory council makes it plain that its purpose is to range over the whole field of fuel and power research and development from the initial laboratory stages to practical industrial use.

How much significance is there in the wording of the terms of reference. They stipulate that the new body—the advisory council on research and development—shall advise the Minister . . . " in relation to his duty of securing the effective and coordinated development of coal, petroleum and other sources of fuel and power in Britain . . ." Leaving aside the curious grammar, these are words that much may be heard of in the Commons, from industry and not least from the miners.

If there is to be Government acceptance on the idea of "guaranteeing" coal a market of 200 million tons a year then there will also have to be Government action.

It is more than likely that the next time the credit squeeze is taken off the leap forward in spending will not necessarily be absorbed by washing machines and refrigerators. It could go into oil fired central heating equipment, both domestic and industrial. If it did the export bill would go on mounting and so would the difficulties of the coal industry.

There is a final clause to the first part of the terms of reference that suggests the Government has no intention of being tied down. The words fuel and power are cautiously followed by "whether produced in Britain or not."

Coordination of advice to the Minister is aimed at in the decision to wind up the fuel efficiency advisory committee, its functions being passed to the new body and a standing committee on fuel technology being formed.

Sir Alexander Fleck, the former ICI chairman, is to take the chair of the new advisory council. Its members are drawn from the Ministry of Power, the Gas and Electricity Councils, the DSIR and the National Industrial Fuel Efficiency Service, the Central Electricity Generating Board, the Coal Board and the Atomic Energy Research Establishment.

Only one member is from the universities, Professor M. W. Thring, of the University of Sheffield, where he is Professor of Fuel Technology and Chemical Engineering.

Contour Canal for National Water Grid?

By J. F. Pownall

Having published several small contour maps of old canals, the author proposes that a national water grid should be established to combine a Continental style navigation system and a regional water distributor.

OVER the years in various articles I have published seven or eight little contour maps showing level reaches of old canals near the 300 ft contour. Fig. 1 (p. 83) shows yet another example: the ancient Charnwood Forest Canal at about 290 ft level. These contours show the characteristic feature at around that level, of a firm-rock outcrop line, marking where the ground steepens to the rising hills. The railway coming later has copied the canal line, without the windings, to keep on the level itself, gaining also the directness of the generalised outcrop contour.

I had dealt earlier[1] with the old canal surveyor's use of the outcrop line, and in a later article[2] with the project for a broad waterway, the Grand Contour Canal,[3] to be uniformly level at 310 ft a.o.d., and to be dually a Continental style navigation and regional water distributor.

The projected canal being almost on a single level, the current arising from its use as a conduit will have to be induced mechanically (in either direction as required) and without appreciably introducing the delays of locking to a lock-free canal. The problem is not difficult but interesting, and the reader may like to be left to formulate his own ideas on the best devices. As a working assumption I take the allowable current to be 1 m.p.h. averaged over the waterway section, which, as provisionally proposed, would be 100 ft wide between side walls, 17 ft deep and 1,500 sq. ft in area. The fall in the water surface is assumed to be limited to 1 ft nominal, plus some inches extra allowance for adverse windage. Allowing 12 miles to be the spacing between low lift installations for restoring this loss of head, then the gradient of 1 ft in 12 miles will correspond to a discharge of 2,000 cusecs or 1,078 m.g.d. For a fall of 1 ft in 12 miles the discharge would still be 690 cusecs.

The Grand Contour Canal has the layout to convey water in this quantity from the high rainfall regions of the Pennines, Wales and the south west, to the dry and drought-prone districts of East Anglia and the south east, serving the chief industrial areas on the way. From the larger hill streams there would lead off feeders graded to take a strong current during such time as the streams are in copious flow. As completed with various distributors the system would constitute a National Water Grid.

OTHER FORMS OF WATER GRID

A pipe line form of water grid was proposed in the thirties by the late Alan Chorlton, M.P. Such a grid would best suit treated, potable water and a small scale of deliveries, and would probably be the most convenient to supply authorities. A pipe line would not suit so well the conveyance of raw water, which it would be pointless to treat where irrigation is a main requirement. A third variety of grid would be the lined tunnel which would probably be driven near the planned hydraulic gradient but could readily siphon under crosswise valleys. It would be intermediate in characteristics between the first two forms.

I have invoked the lined tunnel type to complete the Grand Contour Canal as a grid into south east England where continuous suitable contours are not available. Another tunnel would extend into Cornwall.

The first point about a water grid is that it must have the capacity to do the job completely or not at all. Construction might be phased in easy stages, but designs must expand to a complete plan. The Grand Contour Canal must then supplement existing supplies up to the full requirement, which will vary from place to place.

The primary operation of the contour line grid must be to draw from well-flowing hill streams in the Pennines, Wales and the south west, and to deliver the water across country. It should be conserved to the standard of a good river water by disallowing ingress of effluents, pavement wash, etc. Part would be sold currently as raw water to supply authorities, industrial users, and when required, for irrigation, and part would be stored in various ways against dry spells during which the hill streams will sink below the intake weir levels, as fixed by authority.

On this point the grid derives great advantage from its geographical grasp which enables the rain to be caught wherever it falls, which it does in endlessly varying incidence. Whichever hill region gets a good downpour can currently feed the grid which then needs to incur far less storage charges than the equivalent in separate undertakings would. Drought, for example, can occur in East Anglia simultaneously with steady rain in Wales, which then can supply the irrigation water by simple direct conveyance for a small cost which will be that of pumping a total of about 25 ft, in the successive 1 ft lifts.

NATIONAL GRID IN OPERATION

Grid water will be stored in various ways, but especially by causing it to percolate into permeable strata where it is stored as ground water, to be abstracted by bore hole pumps or adits as required. The contour line in its long course passes by a great range of well-known aquifers—chalk, lower greensand, oolite limestone, bunter sandstone, magnesian limestone, carboniferous limestone, and various drift sands and gravels—and can select those formations well placed between impermeable clays and shales to hold the water charged into them.

The grid can just as well use aquifers which are so masked by impermeable beds as to be deprived of natural replenishment by rainfall. In such sealed-up rocks where underground circulation may be completely prevented, the contained water is often saline—sometimes indeed what the geologists call "connate" water, the original sea water in which the strata were deposited! Examples of the freshening up of such formations by persistent pumping show that a flushing out operation from the grid would in time be successful, and would establish the formation as a useful storage of fresh water.[5]

A water grid can aid river conservancy in various ways. A very simple low cost operation where feasible would be to allow water from the grid to gravitate from the 310 ft level into receptive formations—thick sands would be very suitable—whence the water would issue in a delayed and evened out flow as an augmentation of natural springs, to aid dry-weather flows in the streams. Modifications of this method could give greater positive control, but probably for some greater cost.

In the other direction of flood relief, the aid derived from ordinary abstractions by the grid could only be small in relation to great floods, for which the steeply graded natural watercourses must remain the main channel. But in a few cases, branches of the contour line could provide a shorter route to tidal water, such as, notably, a short cut for Thames headwaters to the tidal Severn, using the Stroud branch of the 310 ft level canal.

The writer proposes that the ownership of the Grand Contour Canal should be entirely with the navigation side, while a publicly appointed National Water Grid Commission should have the non-charged use of the canal as a primary water distributor, in return for special concessions, taxation and other, to the proprietorship.

In this conception, the regional distribution of water is regarded as a judicial rather than a commercial function. The Commission would buy water in bulk from undertakings contracting to it or render credits in some form to the upland areas from which it is abstracted and sell to statutory supply authorities and other bulk purchasers, all these remaining free agents to buy or not to buy according to where the advantage lay. The surpluses from direct trading would be applied by the Commission to various public purposes, for which no commercial credits would accrue.

This arrangement serves simplicity. The Grid Commission would be spared the complication of owning multifarious properties—theoretically all the Commission should really need to own would be its ledgers—and control by publishing prices and rates would be far simpler than by publishing countless directives.

It would seem probable that the Commission would charge a cheaper rate for water conveyed direct from current abstraction, and a higher rate for water drawn from storage and the costs thereof included. Accordingly, bulk buyers would have to consider whether they should buy only at the cheap rate so long as available and do their own storage, or whether they should buy continuously from the grid.

Simplicity is again served in that the water supply industry would be spared an upheaval.

AN EXTREME DROUGHT RESERVE

With the assurance derived from its geographical range the grid should act as the extreme drought reserve, so relieving the authorities of that expense margin which is purely to cover a rather rare contingency. Reservoirs need no longer be kept topped up as long as possible against the unforeseeable drought of the century, but may be usefully operated with the grid.

As a typical example of grid operation, the water of a reservoir might be held 10 ft or so below top level, retaining spare capacity so that the reservoir can now act as a flood trap, filling up temporarily but releasing the extra water over a few days to be taken into ground water storage by the grid. If this happens half a dozen times in a winter, it means that some 60 ft extra total height over the water area has been taken into grid storage, and so the reservoir is used to more effect and with a measure of flood relief. Such operation could simply be a matter of arrangement between the Commission and the owning authority.

Old reservoirs which were constructed to the measure of a particular catchment, but have come to adjoin the 310 ft contour line canal might often with advantage be greatly enlarged to fill from the grid.

Supply authorities may be moved to prune down long-accumulated and involved waterworks properties. With a grid at call they may contrive special garden-watering facilities in a drought, possibly for a special charge. It will be clear that all these topics extend to a long list.

Despite the foregoing accommodations between the supply authorities and the grid, many developments associated with a grid must lie entirely outside the scope of present authorities. For one thing they are not cut out for the highly technical requirements usually needed.

I propose therefore that specially promoted Bulk Supply Water Companies should take up the important ground water re-charge projects, to develop them primarily as bulk storages to the grid under contracts arranged with the Commission.

Contracts arranged between a bulk supplies

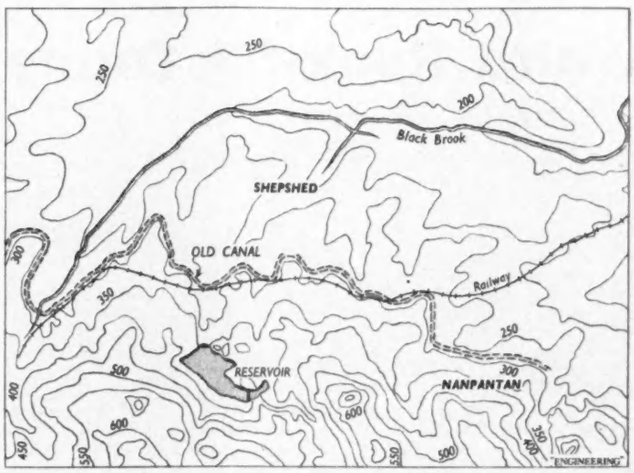


Fig. 1 (above) Charnwood Forest Canal. A level reach along the 300 ft contour.

Fig. 2 (right) The Grand Contour Canal system as a water grid.

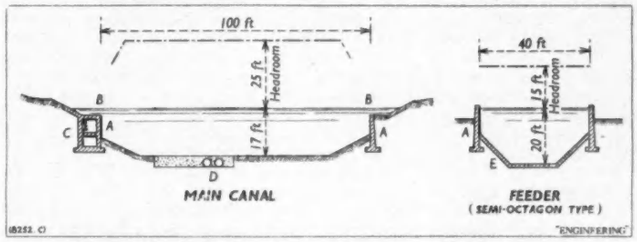


Fig. 3 Grand Contour Canal. Cross section of waterway.

(A) Types of side wall. (B) Two feet of water over top to protect children. (C) Pipes for commercial fluids in box section wall designed as pipe duct one side. (D) Special water pipes in gravel bed where locally required. (E) Revetment.

company and the Commission could be framed by devising sliding scale formulae for the unit rates. A company would not own underground water, the vagaries of which are unpredictable, but would own and have the licence to operate particular works through which water going into or out of store could readily be metered.

I prefer the more commercial form of a company rather than a public board for these bulk and supply projects for reasons which I might illustrate in the case of a North Wales Bulk Supply Company which I formulated two years ago, being then apprised that a sea-bed pipe line could be laid by an established method 5 miles across the Dee estuary. The project included a recharge scheme in the down-faulted Bunter Sandstone which floors the Vale of Clwyd and a high dam in the Cowlyd to store 10,000 million gallons from catchments to the west, and to be built of slate slabs as a special demonstration in aid of the quarrying industry.

Now no consulting engineers employed by a public board would feel themselves in a position to involve their clients in so many problematical features, especially in a scheme, however laudable, to help the depressed slate industry, and in intricate negotiations with the Central Electricity Generating Board which owns the existing small Cowlyd dam and reservoir. If the clients were business-like promoters firmly prepared to carry through with these difficulties, it would be a very different matter. So really the case is for a return to Victorian enterprise.

RE-CYCLING WATER

Trade water schemes, such as the well established one at Warrington, able to supply in bulk, water at about half price, are of course economical to the industrial user, but require duplicated mains. Where water can be re-cycled on the lines of the recent article (ENGINEERING, 1 July, p. 21) there is special advantage in eliminating that much trade waste, relieving the main drainage and sometimes recovering valuable minerals. There is a distinct field open to trade water companies based on supplies ex grid but re-cycling water to the maximum extent, and associating the trade water pipe lines with the piping of commercial fluids and gases. It is obvious that this coming public service must be based on grouping pipes (with caution as to their contents) in a common duct, and so why not make the duct itself carry some low valued fluid, particularly trade water?

A third form of special water company or syndicate, for irrigation water delivery, might be appropriately formed by farmers along a distributary, or sometimes an old canal so used.

TRANSPORT SERVICES OF THE GRID

Special qualities of water may be locally distributed by pipe lines set in the bed of the contour canal, devising an economical water pipe in water arrangement. This might suit delivery of pure soft water to bleaching works. There would always be the tank barge for a special water, such as sea water for marine aquaria inland.

The great aid of the 310 ft level canal towards the purity of rivers and even coastal waters must lie in the facility of transport in large barges, 1,000 tons or more, of composite manures, produced from sewage and solid wastes by well studied methods. It is obvious that very low cost transport from the source localities of such material to the agricultural areas using it is a definite problem, and 1,000 ton barges able with equal facility to navigate coastwise and on the Grand Contour Canal should make practical even the economic treatment of crude sewage now discharged into the sea. The large barge could also dispose of foul silt settled out from streams in industrial areas.

Is the 2,000 cusecs delivery rate as given earlier of the right order? My agricultural advisers concur with equating this delivery with dry weather irrigation for the 1,000 sq. miles of crops requiring it; grassland, roots, sugar beet, soft fruits, etc. Into the area east of a Hull-to-Weymouth line, the contour line grid would introduce 4,000 cusecs for six months in the year, which is stated to be about equal to the future irrigation demand for an average year. In a very dry year the area could overdraw its ground water reserves. I therefore render this as evidence that the Grid Contour Canal is planned on a scale at least necessary, and that no lesser scale would suffice.

In a memorandum I recently submitted to an All Party meeting at the House of Commons on the National Water Grid, I concluded that " it is submitted that a National Water Grid Commission could in provisional form be established to initiate discussions and negotiations and power to arrange contracts with promoters of bulk supply schemes which are advance instalments or precursors of a water grid."

Special forms of gates and low lift pumps for inducing the flow along the 310 ft level canal are of course a first necessity. For re-charge operation, using turbid near-flood waters, economic rapid filtration is essential. For this there is available the Ranney Collector for drawing unfiltrated water from gravels, and alternatively rapid action filtration plants. Adit boring machines which can work remote controlled in unwatered permeable strata are required as also are devices for breaking up or improving the receptivity of underground formations. Development work should include spray equipment suited to irrigation contractors, and pipes, meters, etc., suited to public service industrial fluid piping; while experiments towards high discharge, laminated flow pipes, only a speculation at present, would be of special interest.

REFERENCES

[1] ENGNG., vol. 156, 1943, p. 281.
[2] ENGNG., vol. 176, 1953, p. 741.
[3] This name is due to the late J. M. Lacey, M.I.C.E.
[4] Sub-Committee on The Growing Demand for Water (Central Advisory Water Committee), First Report, Second Report, HMSO.
[5] *Journal* of the Inst. Water Engrs., March, 1955.

Compaction of Earth and Rock-fill Dams

Cohesive and non-cohesive soils, and soft and sound rock, are used for earth and rock-fill dams. The compaction method adopted should be chosen to obtain economically the minimum compaction required in any scheme.

By Stanley Rodin, M.Sc., A.M.I.C.E., M.A.S.C.E.

Head of the Advisory Section, Central Laboratory, George Wimpey and Co. Ltd.

A GREAT many earth and rock-fill dams have been built to meet the demand for water storage, hydro-electric power, irrigation and flood control. Rapidly increasing knowledge of the behaviour of soils, and the great advances in earth moving and compaction plant, enable earth and rock-fill dams to be designed with far more confidence and more economically than was formerly the case. In consequence, an increasing proportion of dams are now being built with earth and rock-fill in comparison to concrete and masonry dams.

The Daer Dam, the Usk Dam, the Quoich Dam and the Selset Dam are but a few of the earth and rock-fill dams recently constructed in Great Britain. The Hirfanli Dam in Turkey and the Wemmershoek Dam in South Africa are notable examples of British construction abroad. Among many other dams notable for their size are the Trinity Dam which will be the highest (537 ft) earth-fill dam, and the Oahe Dam, which will contain 81 million cu. yd of earth fill; both are being constructed in the USA. The Saad-el-Aali, or High Dam at Aswan on the Nile, and that proposed for the River Volta in Ghana, are also rock-fill dams.

This article reviews the latest trends in compaction methods for each of the main characteristic groups of earth and rock fill materials: cohesive soils, non-cohesive soils, soft rock and sound rock.

In 1933 Proctor provided engineers with the important concept that the density to which a soil can be compacted by means of a given effort will vary considerably, depending on the water content of the soil at the time of compaction. This fundamental principle and the associated corollary that there is a single water content—the optimum water content—at which the density achieved by a given compactive effort will be a maximum, has governed the placement control of fill since that time. Because the optimum moisture content of a soil varies with the compactive effort, the standard laboratory compaction test is of limited value and should only be used as a rough guide to the likely field compaction.

In practice, the moisture content for compaction should not be selected solely as a result of laboratory tests, but should be related to the natural moisture content of the soil at the time of construction, the site conditions, and the physical characteristics required of the fill material.

At the commencement of any project it may be pertinent to inquire why the fill material is being compacted. A tendency has developed of late among some engineers to regard the compaction of soils as an end in itself, rather than a means towards an end. Basically, compaction is required to ensure that the shear strength of the fill is adequate for stability purposes, and that seepage and settlement of the dam are kept within tolerable limits.

The placing and compaction techniques used should be those which will achieve most efficiently and economically the minimum degree of compaction required for the particular embankment.

As yet no single compactor or type of compactor has been developed that fully covers the very wide range of materials that have to be compacted under different site conditions. Though there are a large number of compactors, many of them differing in important details, most of them fall into the well known types such as smooth-wheel, pneumatic-tyred and sheepsfoot rollers, rammers, vibrating rollers and vibrating plates. The selection of the most suitable compactor for a particular job depends not only on the character of the material but also on factors such as the placement moisture content, density requirements and weather conditions; due consideration being given to the cost of construction.

Cohesive soils

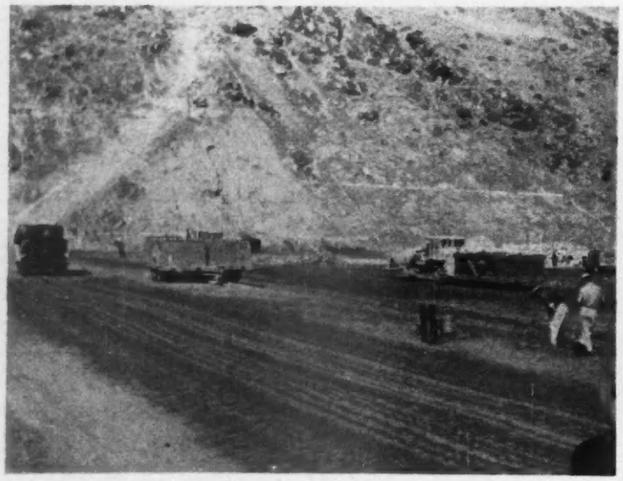
Cohesive soils, such as clays, silts, and granular materials with some clay or silt, are used for the impervious and transition zones in a dam. The sheepsfoot roller has become a traditional tool for compacting impervious zone material. It is normally used on thin layers, about 6 in thick after compaction, and a relatively large number of passes, 12 or more, are required to ensure an adequate coverage and degree of compaction. There is still no agreement on the optimum weight of the roller, and of the foot area and pressure, in relation to compaction efficiency for any particular soil. The latest development in sheepsfoot rollers is the 4-drum self-propelled roller weighing 50 to 60 tons. This type of machine has recently been used on the Navajo Dam and Foss Dam, both in the USA. Under average conditions this machine can operate at about 4 m.p.h. and it is claimed that the output is about the same as three conventional 2-drum rollers pulled by crawler tractors.

Heavy pneumatic-tyred rollers are being used on an increasing scale for compacting impervious and transition zone materials, as they have proved to be more efficient and economic than sheepsfoot rollers, and also less sensitive to changes in the placement moisture content. The heavier rollers, with wheel loads ranging up to 12 tons and tyre pressures up to and even above 100 lb per sq. in, can usually compact layers 12 to 24 in thick; normally, adequate compaction is obtained in 4 to 8 passes. One of the most important developments in these rollers has been the design of suspension systems to ensure a uniform load distribution between each of the wheels when travelling on uneven ground.

Another change is the use of pneumatic-tyred tractor units for hauling the heavy rollers. These units provide greater manoeuvrability than the crawler-type tractors and much higher rolling speeds—in some recent dam construction rollers have been pulled at about 10 m.p.h. The higher rolling speed enables greater outputs to be obtained, even if it is necessary to increase slightly the number of passes to compensate for any lower compactive effort that might result from the higher speed.

Smooth-wheel rollers are used much less frequently now than in the past, though they work well on mechanically stable soils, such as gravel-sand-clay mixtures, and produce fairly good compaction with stiff and shaley clays. As a precaution against the possible formation of a layered or laminated soil structure, which is considered by some engineers to be undesirable from the point of view of seepage, it is the normal practice when using a pneumatic-tyred or smooth-wheel roller to scarify the surface of each lift.

New compacting machines have been used with satisfactory results in some recent dam construction; for example, the Hyster grid roller (the surface of the roll consists of a heavy steel mesh)



A 22 ton double-drum sheepsfoot roller compacting sandy silt in the impervious zone, and a 50 ton pneumatic-tyred roller compacting weathered gabbro in the transition zone at Hirfanli Dam (Turkey).

A spike-tooth roller breaking up lumps of hard boulder clay in the impervious zone at Oahe Dam (USA). This dam will contain 81 million cu. yd of earth fill when completed.

Sluicing coarse alluvium in 22 ft high lifts at Wemmershoek Dam (South Africa).

and the Buffalo-Springfield segmented-wheel roller (consisting of rows of pads around the wheels of the roller). However, insufficient information on the performance of these machines on actual works has been published to make it possible to draw any definite opinions about their merits in comparison with sheepsfoot and pneumatic-tyred rollers.

Wherever practicable, advantage should be taken of the compaction produced by the haulage plant. With some of the heavy earth-moving plant now being used, the wheel loads and tyre pressures are of the same magnitude as the 40 to 50 ton pneumatic-tyred rollers. If a reasonably uniform coverage can be maintained the number of roller passes can be reduced.

Non-Cohesive Soils

Granular soils, such as gravels and sands with little or no clay or silt, are used in the shoulders, filter zones and sometimes in transition zones. Pneumatic-tyred rollers, vibrating rollers and vibrating plates are the principal types of compactors used for such materials.

With vibrating compactors, the deadweight compactive effort of a roller or plate is greatly amplified by the vibration of the compactor. In dam construction, the tractor-drawn vibrating roller is preferable to the self-propelled machine because of the better traction and the ability of the tractor to pull the roller out of "soft" spots. The rollers are made in a range of sizes, the largest being the 8 ton (deadweight) ABG tractor-drawn roller. Vibration frequencies for the heavier rollers vary between models, from about 1,400 to 3,000 cycles per minute; with many models the frequencies can be adjusted over a limited range to suit different soil conditions. In order to obtain effective compaction, towing speeds must be low, generally about 1 m.p.h. or less, and normally adequate compaction is obtained in four to six passes. The 3 to 4 ton vibrating rollers can usually compact layers 12 to 24 in thick. Although the 8 ton vibrating roller will compact much thicker layers, from practical considerations of placing and spreading sands and gravels, it may be better to limit the depth of lifts to about 2 ft.

Self-propelled vibrating plate compactors are made in sizes up to 2 tons deadweight, but their outputs are low in comparison with vibrating rollers. Their use, therefore, is not likely to be economic except for compacting clean, uniformly graded sands and gravels, particularly those with rounded grains, for which the other types of compactors are less suited. The heavy vibrating plates can usually compact lifts 9 to 15 in thick. When the self-propelled plate is operated on a too thick layer of loose soil it tends to bog down during the first pass and the machine becomes difficult to handle. In such cases, its operation is made easier if the soil is first partially compacted by some other plant, such as a smooth-wheel roller.

Pneumatic-tyred rollers do not compact clean granular soils to as dense a state as vibrating rollers. Nevertheless, pneumatic-tyred rollers have been used in many cases for compacting sands and gravels with satisfactory results.

Soft Rock-Fill

Soft rock which can be broken up and compacted to a sufficiently low porosity has been used successfully for the construction of a number of major dams. At Garrison Dam (USA), soft shale was used for the impervious and the random zones, with very little departure from conventional rolled fill construction methods. As excavated and placed on the fill the shale was chunky; the material was placed in 8 to 9 in lifts and modified sheepsfoot rollers with wedge-shaped teeth were used for breaking up the larger chunks. The fill was then compacted with 10 passes of a heavy sheepsfoot roller. The chunky material acted like a gravel under the rollers, rather than like a cohesive soil, the voids between the chunks being filled with pulverised material. At Gavins Point Dam (also in the USA) weathered chalk was used for the main shoulders of the dam. The chalk was spread in 12 in lifts and broken down by several passes of a heavy spike-tooth roller. Compaction was obtained by six passes of a heavy sheepsfoot roller or by three passes of a 50 ton pneumatic-tyred roller; the latter was preferred because it required fewer passes.

With the recent development of powerful rippers and scraper units, capable of excavating soft rocks at a lower cost than the conventional blasting and digging method, it is likely that greater use will be made of soft rock-fill in dam construction. The proper treatment of the material in the borrow pit is an important factor to ensure the good workability of the excavated material. Because of the character of the compacted material, standard laboratory tests are of little use as a guide for the design or construction control of the embankment.

Rock-Fill

In the past the method of placing rock-fill has varied considerably, namely: hand placing individual blocks, as in masonry-type structures; placing in thin layers and compacting with haulage plant, rollers, vibrating compactors or with sluicing; or simply end-tipping in thick layers, with or without the aid of sluicing. The most suitable method depends upon many factors, such as the stability requirements of the rock-fill zones, the properties of the rock (particularly its grading) and the site conditions. Dumping in high lifts combined with sluicing the fines into the voids by high pressure jets has been used on many dams and the resulting compaction has proved satisfactory. Where the latter procedure is practicable, it is usually found to be the cheapest method of placing and compacting rock-fill. In some cases, the higher cost of placing rock-fill in thin layers and compacting with heavy compactors may be compensated by the settlement of the dam being reduced to a minimum and possibly by allowing steeper slopes to be used.

At Hirfanli Dam (Turkey) quarry-run unweathered gabbro, selected to contain less than 10 per cent passing the 1 in screen and having a maximum stone size of about 5 ft, was dumped in 16 to 33 ft lifts and sluiced by monitor jets (2 in diameter, 100 lb per sq. in pressure). The jets, located at the bottom of the tip, were applied first to the material in the truck, so as to saturate it as the truck body was being tilted over, and then on to the material as it slid down the slope of the bank. A similar procedure was also used to place the coarse alluvium in Wemmershoek Dam (South Africa). The alluvium, consisting of boulders of about 2 ft 6 in maximum size down to a fine sand, was placed in 22 ft high lifts. The performance of each of these dams has been excellent.

Steel Community Firms Still Competing

The European Coal and Steel Community has not ended competition among Europe's steel makers. Profits—directly related to iron and steel output—provide the spur to expansion.

THE European Coal and Steel Community has now been in operation for nine years. The transitional period during which special concessions were made to weaker producers ended in 1958. Enough time should have elapsed therefore for an assessment of the effects of the ECSC on the market for coal and steel. One of the most detailed analyses of this question yet to appear is the recently published Twentieth Century Fund study *Europe's Coal and Steel Community*, by Louis Lister.

Markets can be controlled either by a small number of very big firms, or by a number of independent firms agreeing together to fix prices, production or sales. Both of these practices—concentrations and concerted action—are forbidden under the ECSC Treaty. But as they can be taken not only by firms but by Governments interfering in the working of the market, the prohibition in the Treaty is by no means 100 per cent effective.

The ECSC came into being in April, 1951. Between 1953 and 1958 the High Authority authorised very few agreements in steel marketing. Nevertheless, the member firms in large part under Government influence continued to take concerted action on steel prices. There is no evidence, however, of anything like the elaborate agreements on single products of prewar days. The biggest formal agreements cover tubes which are not an ECSC product, and exports to third countries. This latter, known as the Brussels Entente, came into being in March, 1953. The High Authority has avoided making any ruling on whether the Entente violates the ECSC treaty or not, on the grounds that it has no competence over export cartels that " do not influence competition in the Common Market."

Under the ECSC, there is at least one basing point in every steel producing region. The mills in each area are able to align their prices, subject to certain limitations. One of these is that a plant may not sell above its own home list price in another area of the Community where higher prices prevail. Basing points play a major part in the price determination, as transport costs are an important factor in delivered prices. Many firms sell their output through a number of basing points as this enables them to charge a higher average price than if they dealt only through one point. It is important to remember in considering the power of the High Authority to regulate the market, that it has direct jurisdiction only over the producers. The merchants and users of the products can be influenced only through national governments agreeing to take action at the request of the High Authority.

When the High Authority made a ruling in May, 1953, that steel prices should henceforth be free from the influence of individual governments, it set up no upper or lower limits on price movements. The position then was that in the national markets prices were determined by ceilings imposed by the governments. In anticipation of the opening of the ECSC, the national governments had fixed home prices at the level of the minimum export prices agreed by the Brussels Entente, with the result that domestic prices were at much the same level throughout the Community. As business fell off in 1953, the producers found that they could not keep to these prices. However, rather than announce reductions they introduced a system of secret discounts.

This situation maintained the illusion of a uniform Community steel price through 1953 and 1954. After that prices in the member countries again began to reflect national conditions. Firms within the same country discussed prices in their trade associations and agreed on the timing and size of price changes, both together and with their national governments. By 1958 the High Authority was moved to comment on the fact that there were national not Community pricing policies, and that in each country all firms charged the same prices and changed them at the same moment. This pattern of behaviour is not really so very surprising. Governments after all are interested in stable home prices and incomes, and in adequate supplies of steel for use in industry and for export. In cases where home steel prices were higher than those of exported steel, the makers of consumer durables and other goods using a great deal of steel have received a subsidy.

In June, 1958, the parliamentarians joined in the argument. The European Parliamentary Assembly, which consists of delegates from the parliaments of the ECSC countries, adopted a resolution inviting governments to stop interfering with steel prices. This resolution has not resulted in any positive action.

But although steel prices had slipped back into a national pattern of behaviour, it would be wrong to conclude that the setting up of ECSC had no effect on them at all. Trade between the six countries had previously been hampered by tariffs, cartel arrangements and transport charge discrimination. By 1958, there were 41 basing points in the ECSC and buyers in all six member countries were free to choose whichever they liked and to arrange transport. During the years 1954-1957 there was a sellers' market for steel. Under Article 60 of the ECSC Treaty the only way in which producers could take advantage of the fact that prices were higher in another part of the area was by raising prices at their own basing point. As national pricing policies, except in Belgium-Luxembourg, did not allow home prices to react in this way the ECSC regulations apparently meant that steel producers would satisfy home customers first, and then export the rest of their output to countries outside the ECSC where higher prices could be obtained.

Trade in steel between France, Germany and Belgium-Luxembourg, however, expanded very rapidly during the period 1954-57. In 1952, the main producers traded some 900,000 tons of steel between each other. By 1955 this figure had increased to 2·9 million tons. Steel exports by the three main producers to the rest of the world (excluding Italy and Holland) increased from 6·8 million tons to 8·2 million tons.

Where did these increases take place? Exports to Belgium-Luxembourg by France (including the Saar) and Germany went up from 55,000 tons in 1952 to 165,000 tons in 1955. Nearly 40 per cent of the steel going to Belgium-Luxembourg was in crude and semi-finished form for further processing within the Belgian steel industry. Imports by France from Germany and Belgium-Luxembourg increased from 23,000 tons in 1952 to 570,000 tons in 1955. Some 80 per cent of this came from Belgium-Luxembourg. The biggest increase was in the imports by Germany from the other two producers. These rose from 800,000 tons in 1952 to 2·2 million tons in 1955. To some extent this rise is purely a statistical concept depending on whether the Saar output is counted in France or in Germany. When the Saar is included in Germany, imports of steel fall by about 30 per cent and those of France increase.

The ECSC was fortunate to have the favourable conditions of a sellers' market during its early years. The recession year 1958 provided a test which on the whole was successfully passed by the ECSC countries, although exports by ECSC steel producers to outside countries fell by about 18 per cent, or just under a million tons. At the same time, however, the share of the ECSC steel producers in world trade actually increased. The 1958 recession was not severe enough to touch off cut-throat competition. The effects in the different countries varied. There was a fall in production of 3 per cent in Italy and 6 per cent in Belgium, In Germany, production remained constant, in France it went up by 7 and in Holland by 20 per cent. Trade between ECSC countries increased from 2·3 million tons to 2·6 million tons in the year ended mid-1958.

Italy is the part of the ECSC market in which the effects of increased competition in a recession can be observed. The level of costs and prices there is the highest in the Community. In February, 1958, the transitional period during which Italy had been allowed to charge tariffs on steel imports from other ECSC countries came to an end. Between December, 1957, and February, 1958, Italian steel prices fell by from 6 to 11 per cent. Even so, they were still from 15 to 35 per cent above French and German prices for some products. Allowing, say, 10 per cent for transport costs, it would still have been possible for German and French steel to have been sold at competitive prices on the Italian market. Belgian producers of open-hearth steel could also have undercut Italian makers, especially for those customers who could use either Thomas or open hearth steel. Italian prices were reduced by a further 3 to 10 per cent, according to the product, in May, 1958, but were still vulnerable. The small producers, of whom there are some 65 clustered round Milan, were hardest hit by the price reductions. The big tidewater plants, notably the Finsider-owned Cornigliano works were able to hold their own much better.

*Italian Home Steel Prices Compared with Those in Other Countries. March, 1957 and 1959**
(Germany = 100)

Country	Sections		Wire rods		Heavy plate		Light sheet	
	1957	1958	1957	1958	1957	1958	1957	1958
Germany	100	100	100	100	100	100	100	100
France	110	99	105	94	109	98	105	95
Belgium	133	114	116	105	129	112	106	101
Italy	135	115	129	113	146	133	123	108

Source: HA Sixième Rapport Général, Vol. II, pp. 392-393.

* Open-hearth steel only. Prices are fob basing point. Basing points are: Germany, Oberhausen (heavy plate, Essen; light sheet Siegen); France, Thionville (sheet and plate, Montmédy); Belgium, Seraing; Italy, Nov Ligure (G enoa).

So far, the six member countries of the ECSC have not made any very decided steps in penetrating each other's home markets. What are the prospects of further competition in the market for steel? The conclusion reached by Louis Lister is that so long as the profitability of firms rests on their share of the market, individual concerns will have an incentive to expand.

Against this must be set the various schemes for sharing markets through common sales organisations, quotas or subsidies which reduce the desire to increase individual output and sales. Whether rivalry making for expansion, or restriction becomes the order of the day will depend on whether producers take an optimistic view of future prospects. In either case there is always the risk that there will be more management than competition in a common market, and that for steel is no exception.

Space as a Laboratory

PARTICLE accelerators being built today are so costly that their construction can strain a country's research funds to the limit. In two cases, Dubna and CERN, the machines could only materialise through the cooperation of dozens of countries. The result of combined efforts is a controlled beam of protons with energies of the order of 10 to 50 GeV. It is estimated that with present knowledge and the mobilisation of all available resources, the maximum attainable particle energy is still only about 100 GeV, or 10^{11} eV. But the shower of cosmic rays that bombards the earth constantly contains a small fraction of particles with energies above 10^{18} eV. Super-energetic particles only 300 miles away are a tantalising prospect for the physicist. But space offers other opportunities as well. Quoting John A. Simpson of the United States Space Science Board: "The inner solar system has become one vast laboratory for the investigation of dilute plasmas, magnetic fields, hydromagnetic waves, and shock phenomena that cannot be scaled down properly for laboratory study." (*Science in Space*, National Academy of Sciences, Washington D.C., 1960.) The intriguing possibility of using space for physical research is now occupying the minds of men in charge of the nation's space programme.

Galactic Accelerator

It is not yet clear where the super-energetic cosmic particles originate. The energy spectrum can be readily divided into two parts. At the lower end, below about 50 GeV, there is a demonstrated relationship between sunspot activity and the intensity of radiation. The higher end, extending from 10^9 to perhaps 10^{19} eV, appears to be independent of solar flares, and the few available measurements indicate that, plotted on logarithmic scales as in Fig. 1, the intensity falls off linearly with increasing energy. It is this part of the spectrum that is of interest to the high-energy physicist. There are two current theories to explain the origin of super-energetic particles. According to one theory, the galactic system, shaped like a wheel with the hubs slightly enlarged, can be regarded as an enormous particle accelerator. In a synchrotron the particles are accelerated by bumps delivered through a varying magnetic field. Such a field is presumed to exist in the galaxy. The necessary initial acceleration would be provided by solar flares which act as injectors to the accelerator. As the storage capacity of the galactic system is vast and the time required to accelerate the particles is counted in millions of years, the seven-year period of peak solar activity would be damped out beyond recognition.

Decision Next Year

The difficulty with the galactic accelerator theory is that the composition of cosmic rays is hard to explain. Approximately 85 per cent of the incident super-energetic particles are protons, some 14 per cent are alpha particles, and 1 per cent are heavier nuclei between lithium and iron. It is the presence of the heavier components that is hard to explain: there aren't any in the sun. A competing theory about the origin of cosmic rays circumvents this difficulty by assigning distant and unknown spots in the universe as the birthplace whence cosmic particles jump forth like Minerva from Jupiter's head, fully armed and energised. Experiments are now being conducted to determine which theory holds true If the galactic synchrotron model is correct, then there must be a sharp cut-off in the energy spectrum above 10^{19} eV because the magnetic field of the galaxy is too weak to hold such fast particles.

Survival of Weak Bonds

The objection to the synchrotron model based on the presence of the heavy nuclei has not yet been cleared up satisfactorily, but a clue may have been provided recently at the CERN laboratories. Since early this year, the 25 GeV proton synchrotron of CERN has been in full operation. No sooner were the first results analysed when an important discovery was announced in May. Bombarding an aluminium target, the particle tracks left on the photographic plate indicated that in addition to mesons and protons, the collision produced a number of deuterons. How the relatively weak proton-neutron bond in the heavy-hydrogen nuclei survived the high-energy collision is still not understood, but the discovery, which has since been verified using other accelerators, is of fundamental importance, and may have an important bearing on the cosmic-ray theories.

Uniform Distribution

The Minerva theory may be put to the test by examining the direction from which rays reach the earth. If a significant proportion of the particles approach the earth from unique directions, that would indicate that the particles originated from distinct points in the universe such as supernovae. No conclusive evidence is available from tests which started only last year, but the first indications are that the particles reach the earth evenly from all directions. Instead of deciding the origin of cosmic rays, the tests furnished a great deal of data on the intensity of the cosmic particles in the high-energy range. The important results so far are that the particles are approximately isotropic, and that a total of some 10^3 cross an area of one square metre every second.

Inter-science and International Effort

It has been estimated that the cost of a suitable rocket for putting a two-ton satellite into orbit might be between half to one million pounds. This figure is very different from the cost of actually launching a satellite. The latter would have to include development costs, launching facilities, the satellite itself, and provisions for recovery or television transmission. By the time all is added up, the total cost will be well above £100 million. This is a very large sum as expenditure on pure science goes, but measured with other yardsticks, the figure is not so depressing. A 1,000 MW(e) nuclear power staton, or a 2,200 MW(e) conventional generating plant could be built for £100 million. (The United Kingdom is planning to install about 2,000 MW generating capacity every year.) It is obvious that a single research could never justify the total expenditure. But a large number of projects in high-energy physics, plasma research, comsology, and magneto-hydrodynamics, in conjunction with space exploration and meteorology, might be adequate justification when it is realised that the same research cannot be performed on earth. Would it be unreasonable to advocate an international project for launching satellites along the lines of Dubna and CERN?

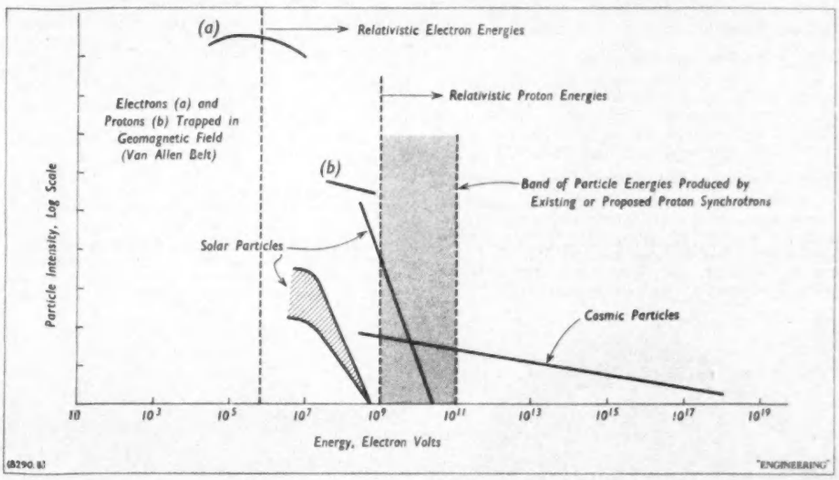


Fig. 1 Energy spectrum of solarflare and cosmic particles, plotted against an arbitrary log-scale.

Interference from Lower Energies

From the point of view of experimentation, the important question is how many super-energetic particles can be expected to fall on the largest bubble-chamber or stack of emulsions that can be sent aloft in a satellite. Assuming for the sake of argument that the cross-sectional area of the emulsion stack is one square metre, the energy spectrum indicates that only a few particles of 10^{16} eV could be expected to strike in a year. It would be extremely lucky if such a small recorder would be struck by one of the particles with energies above 10^{18} eV during the lifetime of the experimenters who sent the equipment into orbit. But at the same time the satellite would be riddled by thousands of less energetic cosmic rays every second. These rays are in the 1 to 50 GeV range—the maximum produced by man-made accelerators today—and would cause serious interference with the experiment.

Controlled Experiments

Thus it is not enough to send into orbit a very large bubble chamber or emulsion stack, a difficult feat in itself, but provision must be made to sift out all the lower-energy cosmic particles that would completely blanket the instrument during its operation. Anyone who has seen a photograph of the shielding mounds provided for the 25 GeV CERN proton synchrotron will appreciate the extent of the problem. But apart from sheer technical difficulty, there is also the question of cost. Fig. 2 shows the approximate cost of present-day accelerators plotted against particle energy. (International Conference on High Energy Accelerators, *CERN Report*, 60-4.) The figures are for the machine only and exclude the cost of land, service facilities, laboratories and other auxiliaries which would be needed whether the particles are accelerated on earth or in space. The lack of a definite trend in costs is due to differences in beam intensity and pulse-rate.

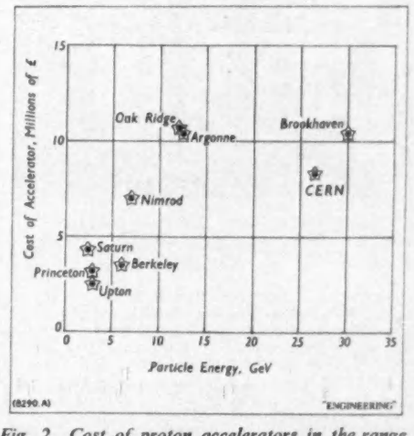


Fig. 2 Cost of proton accelerators in the range of 1 to 50 GEV. No information on the cost of Russian machines is available.

Notes and News

French Link for Allis-Chalmers

Société Rateau will be exclusive licensees of Allis-Chalmers reactor designs in the French Community and the Benelux countries. Rateau, prominent in the field of hydraulic turbines, have contributed to the construction of the Marcoule reactors and are members of the consortium Société des Recherches Techniques et Industrielles (SRTI). Allis-Chalmers

have specialised in boiling-water reactors and are constructing the Elk River indirect-cycle and the Sioux Falls direct-cycle boiling-water reactors. A comparatively late starter in nuclear contracting Allis-Chalmers rose to prominence after the acquisition of ACF Industries. In addition to the Elk River design, ACF have worked on the Oak Ridge experimental gas-cooled reactor, and produced test and research reactors.

Small Reactors for the Australian Outback

Senator Spooner, Australian Minister of State for Power, said that the development of small reactors which could be used economically in remote areas would be of very great importance to Australia. "We could become comparatively large consumers (of uranium) if a reactor were developed which was suitable for use by mining concerns in the outback."

Low-Energy Performance of CERN Synchrotron

Preliminary measurements performed with the CERN proton synchrotron at low energies indicate that the machine, designed for 25 to 28 GeV, will out-perform some of the high-intensity moderate-energy machines that were built for 10 GeV. The mean particle intensity of the CERN synchrotron is in the region of 10^{10} per second at 10 GeV, as opposed to 10^{9} for Dubna and 10^{7} for the Australian proton synchrotron. Only Argonne's zero-gradient machine will show superior performance, with 2×10^{12} particles per second at an energy of 12·5 GeV.

Traffic in Radiographic Sources

In the city of Houston, Texas, there are approximately 80 licensees entitled to use radiographic sources with levels up to 1,400 curies. The licensees transport daily sources in strengths between 3 and 12 curies through the city without accident.

Effect of Carbon on the Uranium-Zirconium Bond

One of the requirements of zirconium-clad fuel-element fabrication is to reduce the carbon content of fuel below 0·1 per cent, otherwise the metallic bond between fuel and can becomes impaired. The obvious methods of decarburisation—oxidation, carbide formation, and hydrogenation—are not practical with uranium. Hence it is essential to select low-carbon ores for the fabrication of this particular fuel, and to maintain the uranium carbon-free throughout the fabrication process. It is possible that alloying the fuel with zirconium will overcome the deleterious effect of carbon on the formation of a metallic bond. (R. H. Weisser: "On the Thermodynamics of the Decarburisation of Molten Uranium," *Sulzer Technical Review*, vol. 41, No. 3, 1959.

Material Problems of Water Reactors

Experience has shown that corrosion rates in water reactors are little affected by irradiation. This discovery makes it possible to perform corrosion studies in simulated reactor loops under non-irradiated conditions. It has been shown that irradiation tends to increase corrosion-product release and redeposition. As a result of this secondary effect, the activity of corrosion products will increase because the released compounds will have passed through the reactor before redeposition. A review of materials suitable for pressurised-water reactors was prepared by Warren E. Berry and appeared in the *Battelle Technical Review*, vol. 9, No. 6, pp. 3-8, June, 1960.

Corrosion of Zirconium Alloys in Steam

It has been shown that under conditions of irradiation in steam or water at high temperature, zirconium metal absorbs the hydrogen that is liberated in the corrosion process. Experience in water reactors has indicated that some Zircaloy-2 cladding failures are accompanied by severe hydriding of the metal sheath. In order to use zirconium alloys as structural materials in water or steam reactors, a useful life of 20 years must be attained, which implies limitations on the hydrogen absorption of the metal. Recent experiments show that hydrogen absorption increases with increasing temperature and increasing corrosion weight gain, and that the rate of absorption does not diminish as the metal approaches saturation. Alloying elements between chromium and copper in the periodic table give percentage absorption greater than 30 per cent, while niobium, antimony, platinum, palladium and molybdenum give 2 to 15 per cent absorption at low temperatures. No absorption of hydrogen has been observed during the corrosion of a zirconium-35 per cent titanium alloy. (B. Cox, M. J. Davies and A. D. Dent: "The Oxidation and Corrosion of Zirconium and its Alloys, Part X, Hydrogen Absorption During Oxidation in Steam and Aqueous Solutions," UKAEA report AERE-M 621.)

Eurochemic: Making a Dream Come True

The year of dreaming was 1956, when the spectre of energy shortage prompted the Organisation for European Economic Cooperation (OEEC) to look towards nuclear energy. The result was the creation of ENEA, the European Nuclear Energy Agency; participation in the Halden and Dragon projects; and the decision to have a chemical reprocessing plant ready for the large-scale power programme that was to follow. Halden's boiling heavy-water reactor went critical in June, 1959; the Dragon project was inaugurated in May this year, and King Baudouin performed the up-to-date corner-stone ceremony for Eurochemic on Thursday, 7 July. Eurochemic's organisation has a curious structure: it is national, international, supra-national, and commercial all at the same time. Created by the OEEC in 1956 under an international statute, Eurochemic will be a joint stock company subject to the rules of commercial law, but in its day-to-day activity will be governed by the laws and customs of the host country, Belgium. Its international status assures Eurochemic freedom from seizure, inviolability of its installations, and exemption from direct taxes and customs duties. But Eurochemic is a trading company and its management is along strictly commercial lines with the number of shares determining the number of votes on the board. The chemical plant will be capable of reprocessing irradiated fuel only with enrichment below 5 per cent in stainless steel, aluminium, magnesium, or zirconium alloy cans. The limitations make the plant unsuitable for handling the fuel from a large number of research reactors, while the European power programme anticipated by the OEEC in creating the plant, has not yet materialised.

Heating and Ventilating Nuclear Facilities

Heating and ventilating requirements of nuclear facilities differ from standard practice in that differential pressure must be maintained between working zones, with the lowest pressure in the zone of highest radio activity; more efficient filtration both at inlet and outlet; and airtight building construction. A summary of recommended design practice with examples from actual installations appears (in Czech) in *Jaderna Energie*, vol. 5, No. 11, pp. 367-372, abstracted in *Technical Digest*, vol. 2, No. 2, Feb. 1960.

Alpha, a Nuclear Tanker Study from Denmark

Danatom, the Danish association for industrial development of atomic energy, has recently completed a comparative design study of three tankers of about 65,000 DWT: the nuclear tanker Alpha, a conventional steam turbine tanker, and a motor tanker. The design work, which required a total engineering effort of eight man-years, has been carried out jointly by Danatom and a number of Danish enterprises. The nuclear version employs a pressurised water reactor similar to that of NS Savannah, with a design power of 83 MW(t). It is equipped with 24 leak-proof control rod drives, fitted on top of the pressure vessel cover. The rods are operated by means of simple hydraulic cylinders in which the pistons are positioned by pressurised water from the discharge side of the reactor cooling water purification plant. The reactor cooling system is divided into three loops, each consisting of two U-tube vertical heat exchangers and two vertical circulating pumps, built as a unit with a canned squirrel-cage induction motor. The bearings are of the self-equalising pivoted-pad type. Some of the reactor plant data are:

Fuel	Uranium oxide, 4·5 per cent enriched
Canning material	Stainless steel
Expected average burn-up	8,160 MWD per tonne
Average design power density	38·6 kW per litre (core)
Reactor flow rate	3,300 t per hour
Reactor operating pressure	106 at. abs.
Bulk coolant average temperature	260° C
Design temperature rise in reactor	18·5° C
Reactor power at 25,000 s.h.p.	76·7 MW
Steam condition at turbine stop valve	30 at. abs., saturated

Natural Circulation for Emergency Cooling

The water purification problems have been investigated in some detail. The system comprises coolers, block orifices, ion exchangers, mechanical filters and a hydrogen addition system. Decay heat removal is normally carried out by means of the purification system coolers and a small circulating pump, but could also be achieved by natural circulation in case of a total failure of the electrical supply. In this case a safety valve, normally isolated from the heat exchangers' secondary side, will serve as heat drain. The reactor plant is arranged within a spherical containment vessel in the reactor room, located immediately forward of the engine room in the space between the two longitudinal bulkheads and separated from the tank section of the ship by double bulkheads. The containment vessel has a diameter of 11·5 m and is surrounded by a secondary shield consisting of concrete and lead. All accommodation for officers and crew is concentrated amidships to reduce the shielding. The layout of the containment vessel and the machinery room are shown in Figs. 3 and 4.

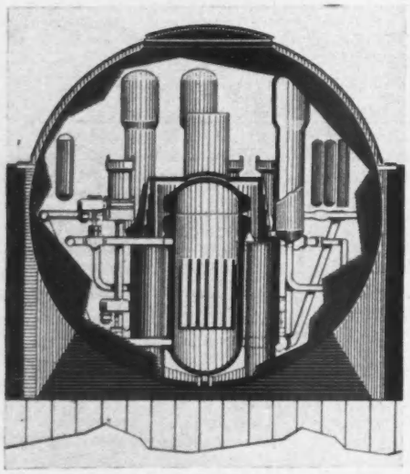


Fig. 3 (left) The reactor compartment of Alpha closely resembles the layout of N.S. Savannah.

Fig. 4 (above) Danatom's pressurised water reactor study for installation in a 65,000 DWT tanker.

Penalty from Load Zones

A comparison of nuclear and conventional propulsion plants for approximately 65,000 DWT vessels indicates that without optimisation the relative cost per ton of cargo, based on 1960 price levels, is 60 for the nuclear version, and 47 and 43 for the steam and diesel versions respectively. The turbine and motor tanker are of conventional design using Pametrada and Burmeister and Wain machinery. The various loadline zones encountered on the route put the nuclear tanker at a disadvantage by reducing the average deadweight. Danatom's gas-cooled power reactor study, BETA, was described in Atomic Review, 29 April, 1960.

Reactor Notes

Towards Nuclear Locomotion: Baldwin-Lima-Hamilton and the Denver and Rio Grande Western Railroad are performing studies of nuclear locomotives on behalf of the USAEC.

Power for Antarctic: The USAEC is inviting proposals to provide a backaged nuclear power plant for erection in McMurdo Sound, Antarctica. The invitation calls for a pressurised or boiling water reactor producing 1·5 MW(e).

Advance with Flair: General Atomics will construct an advanced version of its Triga research reactor, to be called FLAIR. The reactor will be used to evaluate different reflector materials and geometries.

Epicyclic Gear Reduction: Six epicyclic gear reduction units each rated at 1,150 h.p. will be supplied for Trawsfynydd by W. H. Allen Sons.

Auxiliary Burst Slug Detection: The Windscale AGR will be equipped with Plessey auxiliary burst slug detection gear.

The

'Engineering' Appointments

Section

CENTRAL ELECTRICITY GENERATING BOARD

DESIGN AND CONSTRUCTION DEPARTMENT

HEADQUARTERS, LONDON, S.E.1

CIVIL ENGINEERING BRANCH

SENIOR ASSISTANT ENGINEER required in the Civil Engineering Branch concerned with the design and construction of Power Stations and investigations into associated civil engineering matters.

Candidates should have a wide experience in the design and construction of heavy civil engineering works and specialist knowledge of soil mechanics and foundation design. Recent experience in power station design and construction will be an advantage and preference will be given to those who are Corporate Members of the Institution of Civil Engineers.

Salary within the range £1,695—£2,240 p.a.

Applications stating age, qualifications, experience, present position and salary, to the PERSONNEL OFFICER, 24/30, HOLBORN, LONDON, E.C.1, by 2nd August. Envelopes should be marked "Confidential Ref. ENG./261."

C 568

PUBLIC APPOINTMENTS

THE UNIVERSITY OF LIVERPOOL

Applications are invited for two posts of LECTURER in the Department of Building Science. The initial salary for one post will be within the range £1050-£1350 per annum, and for the other post within the range £1050-£1625 per annum, according to age, qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, quoting reference CV/E, should be received not later than 30th JULY, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. C 525

SOMERSET RIVER BOARD

MECHANICAL ENGINEERING ASSISTANT

Applications are invited for the post of MECHANICAL ENGINEERING ASSISTANT in the CHIEF ENGINEER'S DEPARTMENT.

The person appointed will be required to supervise the staff of the Board's Depot, which maintains 18 excavators and 14 road vehicles, as well as 7 oil-engined pumping stations. He should preferably also have a knowledge of electrical machinery.

The salary will be on the scale £880 rising to £1065 by five annual increments and the post is superannuable. Car allowance on the essential user scale will be paid.

Applications, giving as much information as possible about the applicant's experience, should be sent to me by the 29th JULY, 1960.

E. L. KELTING, O.B.E., J.P., M.I.C.E.,
Barrister-at-Law,
Engineer to the Board.

THE WATERGATE,
WEST QUAY,
BRIDGWATER, SOMERSET. C 531

QUEEN MARY COLLEGE (UNIVERSITY OF LONDON)

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING tenable 1st October, 1960. Salary scale £1050 by £50 to £1400 by £75 to £1550 (efficiency bar): by £75 to £1850, plus London Allowance £60, F.S.S.U. participation and family allowance of £50 for each child. Initial salary according to qualifications and experience.

Application forms, obtainable from the REGISTRAR, QUEEN MARY COLLEGE, MILE END ROAD, E.1, to be returned by AUGUST 8th. C 562

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

Appointment of

LECTURER IN CIVIL ENGINEERING

Applications are invited for a LECTURESHIP in CIVIL ENGINEERING, with the title and status of Lecturer in the University of Manchester.

A special interest in, and practical experience of Hydraulics or Soil Mechanics is desirable. In addition to normal teaching duties, the Lecturer will be responsible for research and experimental work in this subject. A new Hydraulics Laboratory is at present being planned.

Salary according to qualifications and experience in the scale £1050-£1850 per annum. Superannuation under the F.S.S.U. Family Allowances.

Conditions of appointment and form of application may be obtained from the REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, MANCHESTER 1. The last day for the receipt of applications is SATURDAY, 30th JULY, 1960. C 530

BOROUGH OF SWINDON

GRADUATE ASSISTANT ENGINEERS

Applications are invited for the appointment of GRADUATE ASSISTANT ENGINEERS in the BOROUGH ENGINEER'S DEPARTMENT.

Applicants should either already hold a Degree in Civil or Municipal Engineering, or expect to obtain one at this summer's examinations.

Swindon is expanding very rapidly to accommodate overspill population from London, and successful candidates would have excellent opportunities to obtain a wide practical experience in the design and construction of the engineering works about to commence for the development of a square mile of open country for industrial and residential purposes. These include main roads and roundabouts; sewage pumping stations and rising mains, large surface water sewers, storage lagoons, and stream improvements; as well as normal road and sewer works for estate development.

The salary will be on A.P.T. Grade II (£765-£880). A five-day week is in operation. Housing accommodation will be offered to married candidates from other areas, and assistance towards removal expenses will be granted.

Application forms, obtainable from the TOWN CLERK, CIVIC OFFICES, SWINDON, must be completed and submitted by FRIDAY, 29th JULY, 1960. C 490

MSL *have been retained to advise on the appointment of a*

MANAGER OF SALES ENGINEERING

for a company in the Midlands specialising in the development, design and provisioning of industrial heating equipment. The company, which is at present engaged mainly in the steel industry, is expanding its activities to cover a wider field and is increasing its technical sales division to meet the heavier demand.

The appointment carries responsibility to the Director and General Manager for the administration of the technical sales organisation which covers the outside staffs, and the provision of estimates, quotations and specifications.

Candidates must have a sound engineering background, preferably in the steel industry, an intimate knowledge of the trade and several years' experience of technical sales management. A knowledge of instrumentation and electrics would be useful and a degree or other professional qualification or a diploma in fuel technology would be a strong recommendation.

Preferred age 40-50. Starting salary, which would be by negotiation, would be approximately £2,500 plus a non-contributory pension scheme and a car.

Please send brief details in confidence, quoting reference F.2517, to M. B. Berks. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED, 17, Stratton Street, London, W.1

C 557

ENGINEERS

are required by the United Kingdom Atomic Energy Authority in its Engineering Branch at Risley, near Warrington, to be responsible for the inspection and progressing of a wide and often novel variety of engineering plant and equipment under manufacture at Contractors' works.

Candidates should be able to assess production problems associated with development work and assist in the solution of problems arising during the production of equipment and assemblies involving special metals, plastics and electrical equipment. Close co-operation with design and construction engineers and considerable travelling within the United Kingdom will be necessary.

Applicants must have served a recognised engineering apprenticeship and possess corporate membership of a senior engineering institution, or equivalent. Wide experience in a large engineering organisation engaged on medium or heavy engineering, in modern techniques involving manufacture, in fabrication and installation and of cost control is required together with initiative, drive, and the ability to direct a team of engineers.

Salary will be assessed on the scale £1880 to £2180 according to age, qualifications and experience.

Contributory Superannuation.

Staff housing scheme.

Send postcard for application form, quoting reference 317/J2, to:—

RECRUITMENT OFFICER
U.K.A.E.A.
DEVELOPMENT AND ENGINEERING
GROUP HEADQUARTERS
RISLEY, WARRINGTON
LANCASHIRE

Closing date: 1st, August, 1960

C 526

DERBYSHIRE EDUCATION COMMITTEE
CHESTERFIELD COLLEGE OF TECHNOLOGY

Principal: E. CARDWELL, M.Sc.(Lond.), Wh.Ex., M.I.Mech.E.

Applications are invited for the following full-time posts:—

ASSISTANT GRADE B in the DEPARTMENT OF ELECTRICAL ENGINEERING AND MATHEMATICS to teach ELECTRICAL ENGINEERING.

ASSISTANT GRADE B in the DEPARTMENT OF ELECTRICAL ENGINEERING AND MATHEMATICS to teach MATHEMATICS. (Two posts.)

Applicants for the above posts should be graduates or hold an equivalent qualification and should be capable of teaching the subject up to Ordinary National Certificate standard. Previous experience is desirable but not essential.

Salary according to the Burnham Technical Scale for Assistants Grade B, (Men £700 by £27 10s. 0d.—£1150; Women £630 by £22—£920 plus equal pay increments) with additions for graduates and allowances for other approved experience.

Further particulars and forms of application from the undersigned to whom applications should be returned by 25th JULY, 1960. Please quote reference 45f.

S. A. BROADWELL,
Registrar.

COLLEGE OF TECHNOLOGY,
INFIRMARY ROAD,
CHESTERFIELD. C 555

BRITISH INDUSTRIAL PLASTICS LTD.

DRAUGHTSMEN

B.I.P. Chemicals Ltd., Oldbury, Birmingham, have vacancies for Draughtsmen with experience in plant layout and design. The company offers good conditions of employment and has a generous Pension and Life Assurance Scheme.

Applications should be made in writing giving full details of qualifications and experience to :—

Personnel Manager,
B.I.P. Chemicals Ltd.,
Oldbury,
Birmingham

C 415

MINISTRY OF LABOUR

PRECISION GRINDER (with sound knowledge of General Eng. Mach. Shop practice) required for appointment as Instructor (Unest.) at the GOVERNMENT TRAINING CENTRE, SLOUGH, BUCKS. Applicants must be British subjects who are (*a*) experienced and fully skilled, (*b*) able to teach their trade, (*c*) supervise the work and maintain control of trainees engaged in their trade. They should have undergone the training usual in their trade followed by at least 5 years' practical experience. Applicants should preferably possess O.N.C. or C. & G. Cert., or equivalent qualifications, where appropriate. Selected applicants will be required to pass a Theoretical Test before appointment and a Practical Test of normal trade skills after taking up appointment. Commencing salary (at age 30 and over) £930 rising by annual increments to £1000 p.a. Prospect of eventual establishment.—Write for application form to EMPLOYMENT EXCHANGE, SLOUGH, within 7 days. C 549

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(*a*) Roads, pavements, earthworks and storm-water drainage.
(*b*) Foul drainage and sewage disposal.
(*c*) Water supply and distribution.

Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially. Salary ranges from £680 (at age 25) to £900 per annum. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.d. LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or apply to any Employment Exchange quoting King's Cross 3746 giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 889

LONDON COUNTY COUNCIL
SOUTH EAST LONDON TECHNICAL COLLEGE

ASSISTANT LECTURER, GRADE B, required to teach Production Techniques, Workshop Practice and Technology of Instruments in the Final C. & G. Instrument-Making course, S.E.3, Mechanics and Drawing.

Salary within the range £736-£1486 according to age, experience, training and qualifications.

Application forms obtainable from SECRETARY AT COLLEGE (FE3a/E/1853/7), LEWISHAM WAY, S.E.4, returnable within two weeks of advertised date. C 541

STATION ENGINEERS

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and Ministry of Aviation Stations. The work of Station Engineers (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineers (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Candidates must hold O.N.C. Elec. or Mech./City and Guilds Electrical Technicians Certificates/2nd class M.O.T. Certificate or equivalent and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidate with supervisory experience.

Salary ranges from £680 to £785 rising by annual increments to £850. Commencing salary dependent upon age, qualifications and experience. Opportunities for promotion up to Tech. Grade A, maximum salary £1565 (National rate). Pension prospects. 5-day week. 18 days paid leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applicants, who must be natural born British subjects up to age 55, should write stating age, qualifications and experience, to MANAGER (P.E.1), MINISTRY OF LABOUR, P. & E. REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 885

ELECTRICAL ENGINEER

to be responsible for the operation of all electrical machinery associated with a prototype naval reactor, situated at Dounreay, Caithness, Scotland, and to be capable of advising on Power Electrical matters.

Marine experience will be an advantage and candidates should hold a University degree, although exceptional men with H.N.C. would be considered. They should be members of the Institution of Electrical Engineers, or have the necessary theoretical and practical qualifications for corporate membership.

Experience is essential in the operation of heavy A.C. and D.C. rotating machinery, together with associated switchgear, control and distribution systems. Some familiarity with electronic instrumentation is desirable but not essential, and arrangements will be made for the successful candidate to receive adequate specialised training.

A contributory superannuation scheme is in operation, and applications, which will be treated as strictly confidential, should give full details of qualifications, present employment, and salary received. All applicants must be of British nationality.

Please write the first instance to:—

The Manager,
Marine Propulsion,
Research and Development Department,
VICKERS-ARMSTRONGS-ENGINEERS-LIMITED
Naval Construction Works, Barrow-in-Furness, Lancashire

C 553

County of Borough of Southampton
EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

Inquiries are invited from Electrical and Mechanical Engineering companies who would be interested in tendering for work in connection with

(*a*) ELECTRICAL MACHINES LABORATORY
(*b*) STEAM ENGINES LABORATORY

The work involved would be in each case the preparation of detailed layouts and specifications in co-operation with the specialist teaching staff, undertaking inquiries and obtaining quotations for approved machines, arranging for the purchase and storage of machines pending installation, manufacturing main control boards and subsidiary controls to agreed specifications, and carrying out the complete installation of machines and wiring from main supply points or pipe-runs, as the case may be. The firms tendering may nominate specialist sub-contractors for approval.

The College of Technology buildings are expected to be started this year, and the first stage (Engineering and Science, Administration and Library) should be completed within two years.

Inquiries, with particulars of similar works carried out, should be addressed to

CHIEF EDUCATION OFFICER
(Ref. 57/66)
EDUCATION DEPARTMENT
CIVIC CENTRE
SOUTHAMPTON C 559

DRAUGHTSMAN

DRAUGHTSMAN (experienced mechanical and electrical engineering). Southampton vacancy. Applicants must have served an approved apprenticeship; possess technical qualifications up to Ordinary level in either branch, and have completed National Service requirement. Permanent appointment subject satisfactory probationary period. Superannuation and travelling facilities.

Salary range £426 at age 21 rising to £791 per annum according to commencing age.

Apply in writing to CHIEF DOCKS ENGINEER (MECHANICAL AND ELECTRICAL SECTION), BRITISH TRANSPORT DOCKS, SOUTHAMPTON DOCKS, giving full details training and experience. C 550

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

BURTON STREET, NOTTINGHAM

Principal: D. A. R. CLARK, M.Sc.(Tech.), M.I.Mech.E.

Applications are invited for a full-time RESEARCH ASSOCIATESHIP IN MECHANICAL ENGINEERING

This research post offers considerable scope. Applicants should possess an engineering degree of a British University, and the person appointed will be encouraged to prepare for a higher degree if appropriate.

SALARY: £650 by £50 to £750 per annum.

Further particulars and form of application may be obtained from the PRINCIPAL, to whom completed forms should be returned not later than 10th AUGUST, 1960. C 558

BOROUGH OF TOTTENHAM

RESIDENT ENGINEER. Salary £1265 p.a. to £1420 p.a. inclusive for supervision of construction o large diameter concrete sewers, reinforced-concrete culverts and manholes and sewer in tunnel.

Application form and particulars from BOROUGH ENGINEER, TOWN HALL, N.15 (EJ). Applications to be delivered by THURSDAY, 28th JULY, 1960. C 567

SOUTH-WEST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, FOREST ROAD, WALTHAMSTOW, E.17

LECTURER required as soon as possible in the Engineering Department to teach Mechanics of Fluids to Higher National and Final Degree standard. Applicants must have a University Degree and corporate membership of their professional institution.

Salary scale—£1370 rising to £1550 per annum. London Allowance of £38 or £51 per annum.

Apply by letter only (no forms) giving details of qualifications, training and experience, together with three testimonials or the names and addresses of three referees to the Clerk to the Governors at the College. C 461

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS NEW SOUTH WALES AUSTRALIA

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan area or the country.

Commencing salary according to qualifications and experience will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the AGENT GENERAL FOR NEW SOUTH WALES, 56 STRAND, LONDON, W.C.2. C 564

APPOINTMENTS OPEN

TECHNICAL WRITERS

wanted (full-time) with experience in electronics or mechanical engineering to write articles for technical press based on visits to factories, also handbooks, reports, etc. Give full details and state salary required in writing to:—
TECHNICAL WRITING SERVICE, LTD.,
6 GANTON STREET
LONDON, W.1 C 556

SERVICES ENGINEER

A textile company of international reputation has a vacancy for a Services Engineer. He will be required to take design responsibility, under the Senior Services Engineer, for Services plant comprising:—Steam, high pressure hot water, gas, compressed air, vacuum, spinning, finish and unit cleaning, together with ancillary and special purposes plant.

Applicants should have:—

1. Either a Degree or Corporate Membership of the Institution of Mechanical Engineers.
2. At least three years' industrial experience, preferably in a processing industry.
3. A suitable apprenticeship or sea-going training.
4. Preferably some experience of installation work.
5. Approximately 30 years of age.

Salary will be in the approximate range of £1250 to £1800 according to experience. Assistance will be given with removal and other expenses. A Profit Sharing and Contributory Superannuation Schemes pertain.

Applicants are requested to write, quoting Reference 2/E/8 to
BOX C 507, Offices of ENGINEERING.

BOILER HOUSE ENGINEER

B.I.P. CHEMICALS LTD. require at their Oldbury group of factories, an Engineer to take charge of a new and modern boiler house supplying steam for generation and process. Applicants should be Engineers who have had boiler house experience and are conversant with up to date boiler control and instrumentation. The Company offers good conditions of employment and has a generous Pension and Life Insurance scheme. Applications should be made in writing giving full details of qualifications and experience to:—
PERSONNEL MANAGER,
B.I.P. CHEMICALS LTD.,
POPES LANE,
OLDBURY.
BIRMINGHAM. C 517

TECHNICAL SALES ENGINEER

A leading firm of power transmission engineers proposes in the near future to appoint a TECHNICAL SALES ENGINEER to deal with its interests in the Midlands and South Wales areas. Main qualifications for the appointment are (1) good connections with design and development engineers in these areas, (2) several years' successful selling experience, (3) some training in engineering, preferably power transmission. The appointment is a permanent and superannuated one.—Write BOX C 495, Offices of ENGINEERING.

CHIEF ESTIMATOR

Applications are invited for this Senior appointment, preferably with experience of Contractors' Plant or Plate and Structural Steelwork.

Post carries attractive salary for person of experience and ability, together with Membership of the Company's Pension Scheme.

Housing assistance available to suitable applicant.

Apply in writing to the

GENERAL MANAGER
MILLARS' MACHINERY CO., LTD.
THORLEY WORKS
BISHOP'S STORTFORD
HERTFORDSHIRE C 543

CONSULTING ENGINEERS

REQUIRE:—

A SENIOR ELECTRICAL ENGINEER with an Honours Degree to work in Manchester. Senior experience of machine, switchgear and protection design and application in connection with Power Stations is required.

A SENIOR MECHANICAL ENGINEER with an Honours Degree to work in Manchester. Senior experience of thermodynamics and metallurgy with design calculations of various types of thermal plant is required.

MECHANICAL AND ELECTRICAL ENGINEERS either Chartered or with equivalent qualifications required for work on Power Station construction sites. Previous experience and knowledge of thermal plant essential.

Knowledge of languages for the senior positions will be an advantage.

Apply stating salary required to KENNEDY & DONKIN 64, ROYAL EXCHANGE, MANCHESTER, 2. C 494

MANAGER

Precision Engineering Division

Applications are invited for the appointment of MANAGER of the new Precision Engineering Division being set up in the North-West by a prominent and substantial engineering Group. Commencing salary will be the subject of negotiation, but will be not less than £2500 p.a. plus Company car, pension scheme, etc.

The Divisional Manager will be in complete operational control of the new plant which will be equipped with the most modern machinery and will employ about 300 people in the initial stages. He will be responsible to the Director and General Manager of the parent unit for organization, layout and staffing of the factory, and for bringing it into full production. In this task he will have at call extensive technical assistance which will be made available as necessary. Considerable preliminary work on machinery trials, performance figures, draft layouts, etc., has already been done and this information will be made available to the Divisional Manager to enable him to formulate his plans with the least possible delay.

The Division is expected to expand rapidly and the opportunities and scope are therefore unusually wide.

Desired qualifications include a degree or professional qualification in mechanical engineering, with considerable experience of administering and controlling a flow-production plant in the automotive or precision engineering industries. A sound knowledge of modern production and management techniques including production planning and control, materials control and work-study is also necessary. Preferred age about 40.

Please write briefly in first instance,
quoting Reference No. 780, to:—

AA LTD

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

C 569

FIBREGLASS

DEPARTMENTAL MANAGER

If you have a degree or Higher National Certificate in mechanical or electrical engineering, some experience of a continuously operated process, and would like to hold a responsible post in an expanding industry, you are invited to write about yourself to Mr. R. G. Terrell, Production Manager, Figreglass Limited, St. Helens, Lancashire.

You would be given charge of one of the new crown fibre plants including melting, fiberisation and final processing. Your responsibilities would include day to day running and improvement of processes. C 560

BCL

BRITISH CELLOPHANE LIMITED

require a

TECHNICAL SERVICE MANAGER

Applications for the position of Technical Service Manager are invited from men, aged 30/40, having the following qualifications:—

- A good Science or Engineering degree.
- Successful Management experience.
- A balanced interest in current market problems and long-term use development.
- Enthusiasm, drive and ability to get on well with people.
- A practical knowledge of packaging—particularly in respect of Plastic and/or Cellulose films would be an advantage.

The Technical Service Manager will be based on London, W.1, and will be responsible for departmental control of Technical Service Representatives, a Laboratory and a Machine Development Section. He will be required to establish and maintain first class relationship with the Company's customers both in the United Kingdom and overseas by personal contact where necessary. Interviews will take place in London.

Applications to Personnel Officer, British Cellophane Ltd., Bridgwater, Somerset

C 554

AN EXCELLENT OPPORTUNITY

A SENIOR EXECUTIVE is required as personal assistant to Chairman and Managing Director to assist in expanding a well established small Engineering Company, London. Applicants must have thorough administrative experience and hold Mechanical or Electrical qualifications on both practical management and design work. The age group desired is 28-35 years. Leading to appointment of responsible position dependent on initiative, drive and hard work. Salary will be commensurate with qualifications and ability.

Applicants are invited to submit a resumé of experience, etc., which will be treated in strictest confidence by the Managing Director, personally. All replies will be acknowledged.

Please write to BOX C 547, Offices of ENGINEERING.

STEAM ENGINEER

THE MIDLAND TAR DISTILLERS, LTD., have a vacancy for a STEAM ENGINEER at their FOUR ASHES REFINERY, NEAR WOLVERHAMPTON. Preference will be given to applicants who are technically qualified and who have several years of practical experience.

The duties include responsibility for the efficient management under the Works Engineer of a modern water-tube, oil-fired, boiler plant; water treatment plant; and steam turbine generating plant; for the supply of steam and power to an extensive refinery and chemical works.

This is an important key appointment and modern housing accommodation in a pleasant countryside is available to a suitable man. Assistance will be given in meeting removal expenses. A contributory pensions scheme with a generous life assurance is in operation. Salary in accordance with experience and qualifications.

Apply, giving details of age, education, training and experience to: PERSONNEL OFFICER. C 537

ASSISTANT ENGINEERS

ASSISTANT ENGINEERS required for site work by engineering firm specialising in High Pressure Water Tube Boilers and Nuclear Power Stations. Preferable age would be between 25 and 30. Commencing salary would depend on qualifications and experience and there are good prospects for advancement. An out working allowance is paid when working on Site. Applicants should forward full details of their education and previous employment to BOX C 447, Offices of ENGINEERING.

DRAUGHTSMEN

VERSATILE ENGINEERING DRAUGHTSMEN with general experience are required by a Plastics Manufacturing Company employing approximately 2000, with Engineering Department of 400. The work involved includes machinery design and layout, etc., and is of considerable interest. O.N.C. or H.N.C. desirable. A.I.E.S.D. rates and above. Good transport facilities and working conditions. Contributory Life Assurance/Pension Scheme.

Apply, giving details of training, qualifications, experience, age, and career to date, to PERSONNEL MANAGER, BX PLASTICS, LTD., BRANTHAM WORKS, NR. MANNINGTREE, ESSEX. C 534

DESIGN DRAUGHTSMAN

DESIGN DRAUGHTSMAN required to work in Westminster area to assist in designing prototype marine propulsion gears. Position permanent and pensionable.—Apply in first instance in writing to TECHNICAL MANAGER, MODERN WHEEL DRIVE, LTD., LINDO LODGE, CHESHAM, BUCKS. C 538

PRODUCTION ENGINEERING RESEARCH ASSOCIATION

An entirely new appointment being made by the PRODUCTION ENGINEERING RESEARCH ASSOCIATION offers rewarding possibilities to a MECHANICAL OR PRODUCTION ENGINEER with a flair for lucid self-expression and close reasoning. Other essential requirements include good technical knowledge of basic production techniques and equipment, and ability to work with minimum of supervision. Send full details of training, experience and present salary to the SECRETARY, PERA, MELTON MOWBRAY, LEICS. C 479

RUSSIAN TRANSLATORS

RUSSIAN TRANSLATORS AND ABSTRACTORS (PART-TIME) required for all scientific and technical fields. Please send full particulars including special subjects, qualifications and previous experience, to TECHNICAL INFORMATION CO., LTD., CHANCERY HOUSE, CHANCERY LANE, LONDON, W.C.2. C 563

SOUTH EASTERN GAS BOARD
TECHNICAL ASSISTANT TO MECHANICAL ENGINEER, WANDSWORTH WORKS

Some workshop and drawing office experience is necessary and the successful applicant will be required to prepare working drawings for workshops use, to carry out surveys on all services and act as Clerk of Works on minor contracts.

Salary within range of £808-£888 per annum.

Applications in writing, quoting reference V15/1277 and giving full details, should reach the PERSONNEL MANAGER, SOUTH EASTERN GAS BOARD, KATHARINE STREET, CROYDON, within 7 days. C 561

SITE ENGINEER

SITE ENGINEER required by well-known firm manufacturing a wide range of Mining, Roadmaking and Quarry Plant. Must be capable of directing all aspects of plant erection and controlling labour.—Full details of experience, age, salary required and when available, to BOX C 536, Offices of ENGINEERING.

MSL *have been retained to advise on the appointment of a*

WORKS MANAGER

for a light engineering company employing over 100 people, and producing short-run repetition work to close limits of precision, using high-speed automatic tools to machine special alloys.

He will be responsible to the board for the programme of work and the efficient operation of the factory, including costing and production control offices, and time and motion study and maintenance engineers.

Candidates should be professional engineers, with specific experience in a light engineering company where continuous utilization of high-speed machine tools is aimed at. Management and production planning experience are essential. Experience as an operator or setter of automatic machines would be an asset.

Preferred age 30 to 35 years. Initial salary around £1,600. Bonus based on profitability of machine operation.

Please send brief details in confidence, quoting reference F.2488, to D. C. Duncan. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED, 212, West Regent Street, Glasgow, C.2

C 546

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d.
(Minimum charge 18s.)	

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent. on 52.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Royal Rivalries at Trumpington

THE visitor to the Royal Show, at Trumpington, outside Cambridge, walked through exciting avenues of enough agricultural machinery to farm a large part of the county before he reached the rivalries of the grand ring.

And the competition among the machinery companies was every bit as keen as between the owners of the Belted Galloways, the Landrace pigs and the Hampshire Down sheep.

Facing each other across an avenue were two firms with a direct and opposite interest in the form of tractor power chosen by the farmer. The famous CATERPILLAR firm, its factories working to capacity and engaged with expansion schemes, made a good showing of its theme—Farm Better with Caterpillar track-type tractors.

Over the way was the equally eye catching stand, brilliant red paint instead of Caterpillar yellow, of ERNEST DOE and Sons, of Ulting, Maldon, Essex.

Doe won a silver medal at the show for a new appliance. This was the Triple-D (Doe's Dual Drive). It amounts to two Fordson Power Major engine/transmission units coupled into one four wheel, power-steered unit which still has a turning circle of only 21 ft 6 in.

With the two 51·8 h.p. engines in tandem standing in line ahead the Triple-D is 19 ft long. It is the inclusion of a turntable in the coupling that gives the smaller turning circle, whose direct result for the farmer is an increase in the amount of each field that can be ploughed.

Saving Track Maintenance Costs

Selling at between £1,950 and £2,055 according to wheel fittings, the Triple-D has been extensively tested by the National Institute of Agricultural Engineering and so far, although the appliance could be said to be in its infancy, thirty have been sold.

The Doe company makes the direct claim that its silver medal winning appliance saves maintenance costs. In particular it is in effect a 100 h.p. tractor without the costs of maintaining the tracks of a track-laying unit.

Which is where Caterpillar come in with their stand across the avenue. Caterpillar can, and most certainly do, point to the fraction of loading on each square inch of soil imposed by a track-layer compared with the four relatively small points of contact made by the four wheels of a tractor.

The Caterpillar company is well up among the agricultural machinery manufacturers whose exports have substantially increased this year. Their Newcastle and Leicester factories are building for enlarged capacity.

More than three quarters of the company's United Kingdom output is sold abroad.

Worth £1¼ million, an order for sixty tractors for Cuba is being currently fulfilled.

Over four-fifths of Caterpillar's Traxcavators and tracklaying tractors go into industrial and constructional use, outlets that account for a useful proportion of the increased demand.

So much of the engineering side of the Royal is concerned with power take-off from tractors, for mobile work in the field and for temporary jobs in the farmyard, that it is an obvious question what becomes of the makers of independent engines for agricultural use.

Power Take-off and Independent Diesels

And the answer is a simple one. The sales chart of diesel engines for separate use in agricultural applications has shown a steady downward movement.

Fortunately for a company like PETTERS, a subsidiary now of the HAWKER SIDDELEY empire, general industrial use and again constructional appliance uses have more than taken care of this situation.

On the Petters stand at Trumpington ENGINEERING's representative was told that output was considerably increased on last year's figures.

Tractors and the ROVER company's Landrovers have reduced the farmer's need for static engines. Electricity has had an influence in the same direction. But the new movement towards irrigation has an opposite influence. Some farmers are spray irrigating such large acreages that they need static engines of up to 100 h.p. Irrigation, for which the Royal had a well attended demonstration, is attracting adherents at a rate which the water authorities find disconcerting.

Always supposing the water supplies can be maintained this is a development which should revive some of the farm demand for the diesel engine.

Among the implement manufacturers there was a measure of agreement that some of the most interesting development in the immediate future of agricultural engineering lies with the reversible plough. There are divided opinions about the work already done in this field. The ploughing technicalities are inclined to be abstruse although the marks on the field created by the one-way only plough are obvious enough.

Creating an Engineering Service

In a quiet corner of the great showground, fruit and vegetable growers and engineers were finding a company which effectively links the two. For a considerable part of the history of Covent Garden the marketing company of GEO. MONRO Limited has handled the growers produce and at the same time done much more than that.

From advising the growers Monro's long ago went on to producing and distributing agricultural machinery principally soil cultivators.

The Monro Machinery Division is at Waltham Cross, in Hertfordshire. Its Rototillers and Monrotillers are used not only in market gardens and small holdings but find a place in specialised sections of some farms.

The Royal is as remarkable for its people as its appliances. Assisting at the Monro stand was the machinery division's Midland sales manager, Mr. Jack Benger, who has two distinctions, among others.

In the First World War he worked in the select team that produced the Newton Pippin, forerunner of the British Army's Mills bomb. He is also the man who first showed a powered soil cultivator at the Chelsea Flower Show. He and his company by that single act earning the anonymous gratitude of legions of private and market gardeners.

The Monro firm's stand showed an impressive Swiss made cultivator that at £400 was well above the customary price level for these machines in the United Kingdom. A machine that has made impressive sales in Western Germany, Scandinavia and other parts of the Continent, it is probably up against the difficulty in this country that many farmers and other potential users do similar jobs with implements driven from their tractors.

ICI Plastics Show Goes to Leningrad

IMPERIAL CHEMICAL INDUSTRIES' plastics exhibition today follows up its well attended Moscow showing by opening

in Leningrad. It will be at the exhibition pavilion in the Kirov park until 29 July.

Something of the breadth of applications covered by the exhibition is indicated by the inclusion of a motor boat made from " Alkathene " (which is ICI's polythene), pvc conveyor belting for coal and for foodstuffs and an Austin Seven saloon showing ICI plastics in car fittings.

In Moscow the exhibition fulfilled its purpose in bringing ICI engineers and scientists into contact with their Soviet colleagues. The same should take place again with people from the plastics industry of the northern regions.

Mr. Khrushchev (inset) visited the exhibition while it was in Moscow. What was he casting an appraising eye over?

In this case it was Dexion slotted angle. The Dexion company's product was used in putting up a 1,075 sq. ft extra exhibition hall in the courtyard of the Polytechnic Museum.

Special Purposes Demand Leads to New Division

Based upon the demand from the electrical industry for timing and control devices outside the standard ranges, a new Special Products division has been set up by EQUIPMENT AND SERVICES, the automatic electrical timing and control engineers, of Harlow, in Essex.

The complexities of special timing and control applications are not always as involved as the particular user often at first thinks. The principles and methods which a firm like Equipment and Services are able to apply bring such problems within a more handleable compass.

Since the one-off product can still often be made up with some of the standard components and sub-assemblies, the cost is not always what the potential user, contemplating doing the job himself, had feared.

The new E. and S. division will be located at Harlow.

Lord Halsbury to Lead New Electronic Firm

Lord Halsbury, managing director of the National Research and Development Corporation from 1949 to '59 and for five years a member of the Advisory Council on Scientific Research, is to be chairman of the Anglo-American electronics firm, LCE Limited.

LCE has been formed between Joseph Lucas (Industries) and the United States company Collins Radio. The Collins Radio firm employs 13,000 people in the USA, 3,000 of them on research and development. Its sales this year, much of them in the electronics industry, are expected to be worth more than $150 million, including substantial exports to European markets.

It is intended that LCE shall manufacture a wide range of Collins equipment with the aid of technical guidance from the US company. LCE's chief engineer will be appointed from Collins research staff in the United States.

A Lift for Renault

The idea that the Common Market would lead to cut-throat competition has taken some hard knocks over the past two years. The number of amalgamations, concentrations and working arrangements has been very considerable. One very interesting development has taken place quite unobtrusively in the motor industry.

Volkswagen are rightly proud of their training school at Wolfsburg. There technicians of all grades are taught the mysteries of motor making. And far from being exclusively engaged in training its own staff, Volkswagen has always had an open-door policy for its school. Among those to profit from this liberality has been Renault, Volkswagen's biggest European competitor.

Renault is reported to have run into difficulties in maintaining the quality of output of some mass-produced items. Some of the people responsible for quality control and the running of the production lines have been sent to the Wolfsburg school for training. The outing is reported to have done them and Renault a great deal of good.

Why, the advocates of competition will ask, should Volkswagen help out its rival in this way? The answer is apparently very simple and very global. Both companies make enormous sales of small cars in America, the traditional home of the big car. The decline of one famous make of small car there would affect the sales of the rest. In no time at all the word would get round that small cars were more trouble than they were worth. So Volkswagen as the biggest supplier is interested in keeping the market open and expanding. It is not to its advantage to run its main competitor off the road. Whether there is any foundation in the rumours that the two companies might cooperate even further and end competition by amalgamation remains one of the big question marks for the industry.

Parallel Programming in Data Processing

Associated Electrical Industries Limited have opened a new computer centre at Sale in Cheshire to house the equally new AEI 1010 data processing system. This system which was developed by the electronic apparatus division of the company, is claimed to be the fastest available in the world and it incorporates a computer which will handle data at the rate of over half a million characters a second. The computer is capable of controlling a large amount of auxiliary data-handling equipment.

While the company's claim that the system "can handle all aspects of a firm's business" seems a little optimistic, it should certainly cope with stock assessment and control and production planning—among many other things. Indeed, any form of clerical data recording and processing can be handled by one single system, whereas previously computers have been more limited in the amount of work they can do. In addition, the system can provide an up-to-the-minute picture on any aspect of a business such as, for example, the state of production or the stock position, thus enabling management to take action should anything untoward upset the normal flow of business. A unique feature of the equipment is that several different functions can be processed at the same time.

Junction transistors on printed boards are fitted throughout the computer, and the basic computing unit, including working store and control desk, occupies a floor space of only 6 ft 6 in by 2 ft 5½ in.

The fast arithmetic and control unit operates in the parallel mode and makes the 1010 computing unit one of the fastest in the world. Instructions ruch as add and subtract, take 18 μ-sec, while transfer and organisational instructions which are used extensively in data processing take only 13 μ-sec, both times including access time to instruction and operation when required.

There are two 44 digit accumulators which combine to form one 88 digit accumulator for multiplication, division and certain other functions. A further 44 digit register contains the multiplicand for accumulative multiplication. Seven 13 digit accumulators provide "B" store facilities for modification of instructions and for counting, etc. An eighth 13 digit accumulator, formally addressed as "B(o)" is used for automatic relative-address modification. A 13 digit control register contains the instruction address, which may be changed by programme in various ways.

The working store is provided by an immediate access store consisting of a three dimensional array of ferrite cores. It has a capacity of either 2,048 or 4,096 words, each of 44 binary digits plus 4 parity digits and an access time of 3½ μ-sec. Each word has two instructions, both

The AEI 1010 computer is claimed to be the fastest in the world for the automatic processing of data in industry and commerce.

separately addressable. The read-rewrite cycle time is 8½ μ-sec.

A novel feature of the system is the data scanning equipment which transfers data between the working store and all ancillary equipment. The usual method employed by other computers is to assemble a complete block of data in a buffer store when a transfer is required between working store and peripheral equipment. In a large installation this means that a vast amount of costly buffer storage is required.

The AEI system overcomes this problem by using only a single word buffer store for each item of ancillary equipment connected up to the computer. The connection to the computing unit is through multiple data highways which are common to all ancillary control units. An installation can, therefore, be expanded without change to the basic computer, merely by connecting the new ancillary units and their associated controls to the data highways by means of plug and socket connections.

The data scanning equipment scans the 32 single word buffer stores at such a rate that it can transfer a word from one unit as soon as it is assembled, and can then scan the other units, transferring words from them when necessary, returning to the first unit in time to transfer the next word.

Thus, each ancillary unit is allowed to operate at its own speed, independently of the computer, transferring a block of predetermined size, one word at a time, through its associated single word buffer store. Once the instruction which initiates the block transfer has been given, the computer is free to carry out further instructions in the programme, while the transfer of the block is executed word by word. The standard block size is 32 words, but variable block facilities are available for certain peripheral units.

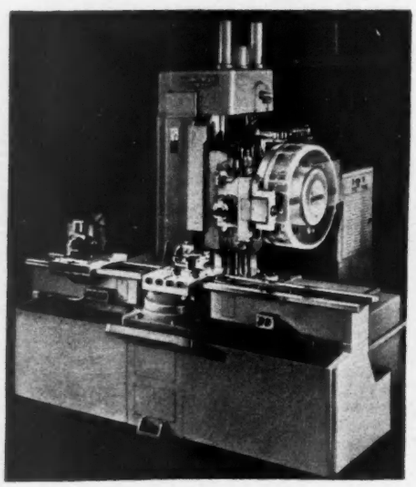
In order that word transfers from or to ancillary equipment may take place simultaneously with the execution of programme steps, the computer contains two control units called the long and short controls. When engaged in a long order (a multiplication or division for example, which may take up to 250 μ-sec), the two controls run simultaneously as soon as the order has finished with the working store, the long control finishing the arithmetical functions while the short control deals with any transfers of data which require attention at that time.

The computer takes 13 μ-sec to transfer a word in either direction from each buffer store, so that the upper limit to the data handling rate of the computer is 77,000 words (each of 44 binary information digits) or over half a million characters per second. Since the peak data rate of most ancillary units is low compared with the peak data rate of the computer it can be shown that a system controlling 32 peripheral units of all kinds (except very fast magnetic tape decks and magnetic drums) cannot exceed the peak data rate of 77,000 words per second. The number of very fast magnetic tape decks and magnetic drums which may be allowed to operate simultaneously will vary from installation to installation. The demand for magnetic drums is usually small (from 1 to 4 in typical installations) and no special arrangements have to be made for their simultaneous operation. Very large systems may, however, require many high speed magnetic tape units to be under computer control although it is rarely, if ever, required to operate them all simultaneously. In such systems a special device will inhibit the initiation of simultaneous transfers from more than a predetermined number of tape decks until one or more of the current transfers have been completed. Thus, in the rare cases where the programme calls for more than the limited number of simultaneous transfers from magnetic tape, there will be a delay of up to 5 m-sec before the additional units can be started up.

Five Machines Replaced by One

Working on a production job at the International Machine Tool Exhibition was the Kearney and Trecker Milwaukee-Matic which was on show for the first time in Britain. It was being used to produce CVA Ia lathe aprons—a job which it completed in 2 hr 8 min; as opposed to conventional methods which needed 12 hr 36 min to complete the job using five machines, including a jig borer. By using the Milwaukee-Matic, the cost of this particular component is reduced by a factor of over three. The machine is a horizontal spindle, tape controlled production unit, capable of performing automatically milling, drilling, reaming, tapping and boring operations in any sequence and on several sides of a workpiece during a single set-up. Incorporated in the machine there is an automatic tool changer which will hold up to thirty different tools. Tool change time is 0·15 min, and is the most lengthy non-productive machine element. The maximum diameter which can be accommodated in the tool changer is 2⅝ in—the maximum length being 7½ in including a 2 in long code ring fitted to each tool.

A special feature of the control system of this machine enables it to perform approximate profiling operations. This feature uses straight lines and circular arcs in establishing the cutter path. Arcs of radii of 0·1 in to 9·9 in can be generated in increments of 0·1 in. Angles are approximated to within $\pm$ 1° of true slope.



The Kearney and Trecker Milwaukee-Matic which will mill, drill, ream, tap and bore automatically.

Repetition Indexing to a Quarter-Second of Arc

The dividing engine fitted on to the table of a machine the boring head of which was made by High Precision Engineering.

On show for the first time at the recent International Machine Tool Exhibition was the Sperry/Orcutt Dividing Engine. The equipment, which many would call an indexing table rather than using the more traditional term, has been designed to provide an automatic means of performing angular division to a high order of accuracy. This it does without the tedium of setting each successive position from a microscope or graduated drum.

The dividing engine has a 31 in diameter circular platen which will carry loads up to 1,500 lb. This platen can be positioned angularly to an accuracy of ± 2 seconds or better and positions can be repeated to an accuracy of $\pm \frac{1}{4}$ second. Control of the platen is by electrical equipment housed in a control console connected to the dividing engine through six electrical cables. Positional control is obtained from information coded on to standard teleprinter paper tape or from a set of dials.

The platen of the dividing engine is driven by two electric motors controlled by a servo system. Information for this servo system is obtained from a series of electrical circuits situated in the control console; the circuits being fed from a large multi-pole synchro fitted to the underside of the platen. The circuits are energised by relays to demand any required angular setting. The resultant unbalance voltage in the circuits is fed into a servo amplifier to drive the electric motors in such a way that the changing synchro output will restore the electrical balance. When this balance is achieved, the motors stop and the platen is clamped in position by an electromagnet. The electronic equipment used for the servo system is fully transistorised and printed circuit techniques are used wherever practicable.

The dividing engine is a joint venture by the Sperry Gyroscope Company of Brentford, Middlesex, and the Gear Grinding Company of Solihull, Warwickshire.

Water Cooled Welding

An interesting welding technique has recently been evolved by James H. Randall and Son Limited of Paddington Green, London, for the construction of over one thousand welded platforms forming part of the new Bank Station Trav-o-lators. These moving pavements, designed by the Otis Elevator Company Limited for whom Randalls, as subcontractors, are manufacturing the platforms, are now being installed at the Bank station of the Waterloo and City Railway which forms part of the Southern Region of British Railways.

The Trav-o-lators are designed and constructed on similar principles to a normal escalator, so that a series of moving platforms, each 40 in by 16 in, form a smooth inclined surface 300 ft long, moving at a maximum speed of 2 m.p.h. on a 1 in 7 slope rather than a series of steps.

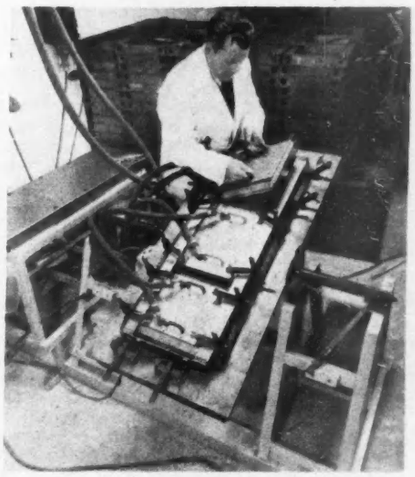
The platforms are fabricated from $\frac{1}{16}$ in steel plate, folded into a box section, with two ribs of $\frac{1}{16}$ in plate and ends of $\frac{1}{4}$ in bright steel plate welded on. Die-cast ribbed sectional treads are then bolted on to this platform unit.

An essential requirement is that there is no distortion of the platforms due to welding so that, when the die-cast aluminium treads are attached, they form a perfectly flat surface. The bearing housings are welded to the platforms to support the axles which form part of endless chains. A second fixed axle is welded into position to carry the trailer-wheels on which the platforms run.

It was therefore necessary for a special fixture to be designed and constructed to hold the platform and its end plates during welding in such a way that the heat involved in making a 22 in weld at each end of the platform could be evenly dispersed without causing distortion.

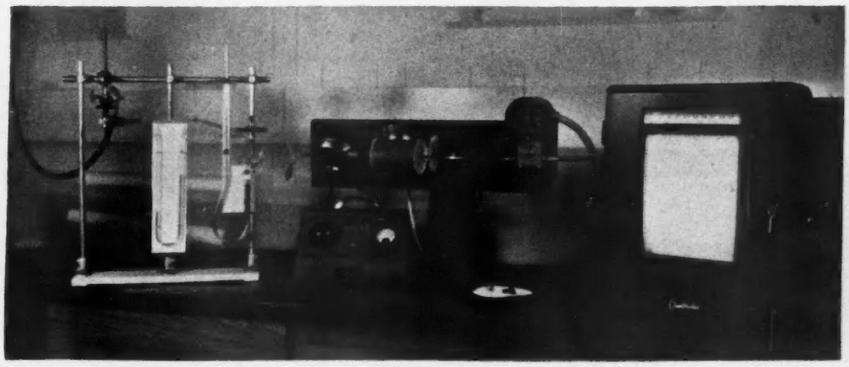
This fixture consists of a surface plate which is pivoted to a fabricated frame so that it can be locked in convenient working positions. Toggle clamps attached to the surface plate hold the main platform sheet and its end plates in their appropriate positions.

To assist heat dispersal, three rectangular copper tanks through which water is circulated by an electrically driven pump, are clamped inside the platform before welding begins. In addition, there are two smaller water cooled tanks built into the underside of the surface plate immediately beneath the two main welds. This method of water cooling, together with the fact that the large mass of metal embodied in the surface plate absorbs and evens out any remaining heat, results in the quick and efficient production of distortion-free units.



The welding fixture with a platform in position, showing the three water-cooled copper tanks for heat dispersal.

Measuring the Hydrogen Content of Steel



The BWRA apparatus for measuring the hydrogen content of steels makes an analysis in 15 min.

The British Welding Research Association of Abington Hall, Cambridge, has recently described a new rapid technique for measuring the quantity of hydrogen dissolved in steels. The analysis time with the BWRA apparatus is 15 minutes as compared with some two hours using more conventional instruments.

The new technique which was described at a recent symposium on the Determination of Gases in Metals, organised jointly by the Iron and Steel Institute, the Institute of Metals and the Society for Analytical Chemistry, uses a carrier gas principle. In this, argon is passed over the sample of steel to be analysed which is heated in a furnace. The gas evolved is swept along to a hydrogen sensitive cell from which the result is plotted directly on to an electrical graph recorder. The system is so sensitive that as little as one part in a million of hydrogen can be detected and measured.

Preventing Fires Sparked by Friction

Fire, a major industrial hazard, can be caused by sparks. Analysis of the risks, which arise from different situations, enables preventive measures to be taken.

By K. N. Palmer, Department of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization

FRICTION sparks have been recognised for a long time as a possible cause of outbreaks of fire. In many industries there are manufacturing or processing operations in which the generation of sparks by friction or impact between solid surfaces can occur in the presence of combustible materials. However, sparks can be insufficiently powerful to lead to ignition, so that not all friction or impact sparks are necessarily hazardous and not all combustible materials are equally easily ignited.

The energies of impact required for ignition and the mechanisms of ignition by friction sparks have been studied in the laboratory, and the results of these researches have recently been reviewed by Titman,[1] Hartmann,[2] and Bernstein and Young,[3] particularly with reference to the problem in coal mining. There is, however, relatively little information on the types of plant and processes that are liable to produce hazardous sparks in industry generally, on the materials that are likely to become ignited, or on the extent to which the ordinary use of non-powered hand tools causes fires.

The Joint Fire Research Organization has recently obtained some information on these aspects from reports provided by the public fire brigades during 1956 and 1957. Details were given of all fires attributed to friction or impact sparks; fires due to other types of spark, or to glowing embers, or to frictional heating without sparks were not considered. No provision was made in the reports for estimation of the confidence to be put in the diagnosis of the cause of the fire, and so all reports were taken to be of equal value. In any case the public fire brigades do not attend all fires that result from friction sparks, but uncertainty about the total number of fires should not affect relative numbers, such as the ratio of numbers of fires in solid to numbers in gaseous combustibles. The types of machinery and combustible materials that are particularly prone to becoming involved in friction spark fires are clear and indicate where the main efforts are required to prevent fires.

INCIDENCE OF FIRES

During 1956 and 1957 the total numbers of fires attributed to friction sparks were 338 and 341 respectively. The great majority of fires occurred in solid materials; in 1957 the solid fires numbered 313 while those in liquids and gases were only 28. Over 60 per cent of fires involving solids originated in textile and allied fibrous materials. The majority of the textile fires occurred in cotton and these accounted for nearly 40 per cent of all the fires in solids; the cotton industry is thus particularly prone to fires caused by friction sparks. The remaining fires in which solids were first ignited occurred in a wide range of industries, prominent among which were the timber, leather and rubber trades. Although they were relatively few the fires involving liquids or gases covered a wide range of substances, the most frequent being petrol (in about 20 per cent of incidents).

In the two years considered there were 679 fires altogether, but only 30 of these were ascribed to low energy impacts such as the manipulation of non-powered hand tools, the use of metal studded footwear, or the movement of heavy objects. In each incident the striker was made of metal, whereas the object struck was metal or stone. An analysis of these incidents is given in the appended table.

The materials ignited by low energy impacts were not a representative selection from all friction spark fires, for instance the proportion of solids was low, and in about half the cases chemically reactive materials were involved. All the remaining incidents occurred in the presence of power-driven machinery. The two types of machinery that predominate are those specifically used in the textile industry and those carrying out abrasive processes such as grinding, polishing, or buffing. In 1957 over 53 per cent of the fires in powered machinery were in textile machines processing the raw material before spinning (breaking, carding, opening and similar machines). A further 22 per cent of fires were due to grinding, etc., and there were also some due to sanding and sawing, mainly of wood.

PREVENTIVE MEASURES

The measures which may be taken to reduce the number of fires due to friction sparks, and the loss involved, fall into three groups: avoiding the formation of sparks, preventing the sparks from causing ignition, and limiting the spread of fire if ignition should occur. Though the formation of friction sparks is inevitable in some operations, such as the grinding of steel on stone, there are means of reducing the likelihood of formation in some other operations. One method of avoiding the formation of friction or impact sparks is the use of the so-called "non-sparking" metal alloys, usually bronzes. These have been used in hand tools, but their use in powered machinery is less frequent. There appears to be much scope for their use in this connection, since there is no doubt that these alloys do reduce the spark hazard. They do not necessarily eliminate it entirely; for instance, sparks may still be produced in the presence of foreign matter.

The figures in the table show that in practice low energy impacts, as from hand tools, cause relatively few fires. The use of non-sparking hand tools is possibly only required in certain industries where exceptionally easily ignitable substances are present. In the petroleum industry in America, where these tools have been fairly widespread, there has recently been a tendency to discontinue their use. The American Petroleum Institute[4] have concluded that sparks from hand tools made of either steel or non-ferrous metal have not contributed significantly as a source of ignition for accidental fires in petroleum hydrocarbons, and that the use of non-sparking hand tools is not warranted.

In processes involving comminution, such as milling, the use of bronzes in the construction of the mill may not be practicable. In this case spark formation may often be avoided by using magnetic or pneumatic separators to remove tramp metal. If the milling process is in two stages the separators should be installed in the plant after the material in process is crushed into coarse lumps, and before the stage of fine grinding.

TABLE.—*Fires Not Due to Powered Machinery in 1956 and 1957*

Object moved	Object struck	Number of fires		
		Solid	Liquid	Gas
Steel hand tools ..	Steel ..	5	3	—
	Concrete ..	1	1	—
	Brickwork ..	—	—	1
	Not stated	5	2	—
Metal boot studs ..	Concrete ..	1	3	—
Metal pipe connector	Brickwork	—	—	1
Various heavy metal objects moved	Steel ..	2	—	1
	Concrete ..	—	3	—
	Not stated ..	1	—	—
	Total ..	15	12	3

Production of friction sparks is inevitable in some operations and in these cases fires may be prevented by ensuring that no combustible material is present. For instance, a practice to be avoided is a common extraction ducting from the grinding of steel on stone and the subsequent polishing of the steel with a fibrous wheel. The combustible fluff from the polishing can collect in the ducting and is easily ignited.

In other operations, if the production of sparks in the presence of combustible cannot be avoided, ignition may often be prevented by inerting the atmosphere surrounding the combustible. Thus, if the oxygen content of the local atmosphere is reduced sufficiently below the general atmospheric value (about 21 per cent by volume) ignition may be prevented. The maximum permissible working concentration of oxygen varies with different combustibles, and a list for some of the more common materials has been produced by the National Fire Protection Association.[5] For example, the maximum recommended concentration of oxygen, when using carbon dioxide for inerting, is 13½ per cent for wood flour, 9 per cent for sulphur, and for certain metals the figure is a good deal lower still. This method of avoiding fires is clearly most useful when the manufacturing operation is partly or completely enclosed.

Though steps may be taken to prevent the formation of sparks and the initiation of fire, consideration should also be given to the prevention of the spread of fire. For instance, personnel should be trained to take the correct action in emergencies, fire extinguishing equipment should be available for first aid use, and the importance of good housekeeping (that is, avoiding the accumulation of inflammable rubbish, waste, etc.) should be stressed. Wherever possible, plant in which fires are likely to originate should be situated in isolated buildings, or contained by fire-resistant structures. In addition it may be necessary to provide some form of explosion venting in the building and plant if the material being processed is liable to cause a dust explosion when a suspension in air is ignited. Information on the materials liable to produce dust explosions and on the safe design of plant may be obtained in this country from the Factory Inspectorate of the Ministry of Labour,[6] and there is a useful Code of Practice on the prevention of dust explosions published by the National Fire Protection Association[5] in the United States.

The work described in this article forms part of the programme of the Joint Fire Research Organization of the Department of Scientific and Industrial Research and Fire Offices' Committee; the article is published by permission of the Director of Fire Research. The author is indebted to Miss J. S. Hall, Miss A. Vincent and Mr. P. S. Tonkin for assistance in collecting the data.

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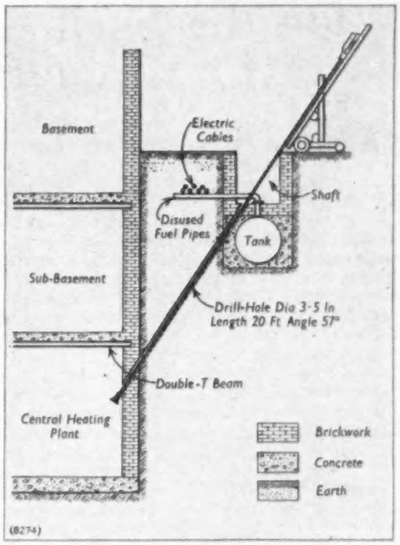
Heating Repairs by Mining Drill

When the oil pipes linking the underground fuel storage tank and the central heating system failed at a shoe factory in Essen, Germany, it appeared that extensive excavations would be necessary. The heating plant was in the basement of a multi-storey building, and the orthodox way of installing new pipes would have involved breaking through a paved floor, through bricks and mortar, a 20 in layer of concrete and 23 ft of earth. It was estimated that the work would have taken about ten working days, taking into account both the excavating and the repairs to the floor.

The possibility of drilling a hole large enough to take a new oil pipe was therefore investigated, and the Atlas Copco organisation suggested using a BVB23 wagon mounted drill, which can work at any angle within an arc of 130°, using 8 ft drill steel changes for holes up to 100 ft in length.

A further complication was caused by the fact that between the oil tank and the basement heating plant there were several electric cables, the exact location of which was not known. They could not be taken out of circuit during working hours, and vertical drilling for the new pipe was therefore impossible. The Atlas Copco drill solved this problem by putting down a hole at an angle of 57° which led directly from the oil tank, passed well below the cables, and entered the basement through the wall beneath the ground. A hole 3½ in diameter and 20 ft long was drilled in two hours.

Sandvik Coromant drill steels were used, and they cut through reinforced concrete, plaster and clay, and also penetrated some iron tees without suffering any damage. From start to finish the time occupied was only six hours. Compressed air for the drill was supplied by an Atlas Copco mobile compressor.



A hole for a replacement oil pipe was drilled in two hours with an Atlas Copco mining drill. Normal excavation would have taken 10 days.

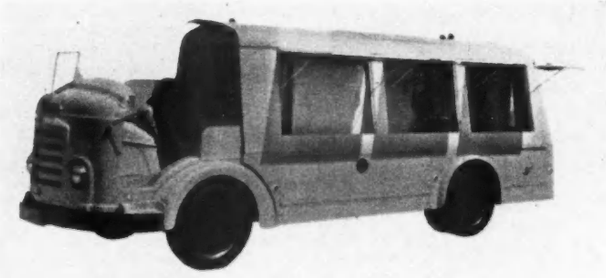
Electrical Servicing for Aircraft

Based on prototype equipment supplied to the Ministry of Aviation, a new electrical servicing trolley built by Auto Diesels Limited, Uxbridge, has a capacity of 60 kVA at 400 cycles per sec. It has been supplied for use in the production of the Handley Page Victor aircraft.

The prime mover is a Leyland 600 industrial engine. Running at 1,500 r.p.m. the engine drives the 400 c.p.s. alternator directly. The mass of the rotor keeps the voltage modulation to a minimum, which is essential for this type of aircraft servicing equipment. An output of 60 kVA at 220/115 V, 3 phase, together with 15 kW at 28·5 V d.c. is available from the unit.

Both the high frequency alternator and the 28·5 V machine are of GEC manufacture, the alternator being of the revolving field type, controlled by a GEC "Accurex" static exciter and regulator.

The equipment is mounted on a Rootes Karrier Bantam chassis, and a weatherproof canopy with access door allows for all weather operation. Maximum forward and upward visions are provided for the driver, so that the unit can be driven safely close to an aircraft. To allow for the different rates of fuel taxation, two fuel systems are provided; one provides fuel for the vehicle engine for road travelling, and the other feeds the engine driving the electrical equipment. There are two battery systems, one for the vehicle engine and the other for the generating prime mover; this battery also supplies current for interior lighting for maintenance purposes.



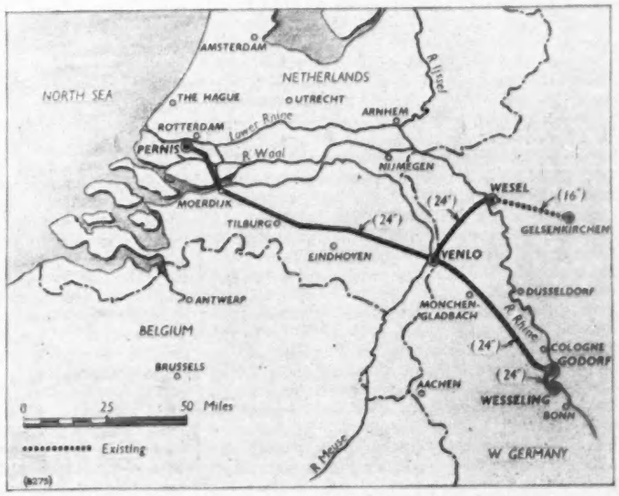
Current at 400 cycles per second is provided for aircraft servicing by this Auto Diesels vehicle.

International Oil Pipeline

Conveyance of oil by pipeline over considerable distances is well established in the USA and some other parts of the world, but a pipeline 185 miles long, recently opened between Rotterdam and Western Germany is the first of its kind in Western Europe. Planned in 1958 and built at a cost of £10 million, the pipeline is 24 in diameter, and has a capacity, at present, of 8½ million tons of crude oil a year. With the installation of more pumping stations, its capacity may be increased to 20 million tons a year.

The new pipeline is owned and operated by N.V. Rotterdam-Rijn Pijpleiding Maatschappij (the Rotterdam-Rhine Pipeline Company) 40 per cent of the shares are held by the Royal Dutch/Shell Group, 40 per cent by Gelsenberg and Mobil Oil Handels und Transport Gesellschaft, and the remaining 20 per cent by the California Texas Oil Corporation.

From Pernis, in the Rotterdam petroleum area, the pipeline runs a distance of 95 miles to Venlo, where it divides. One branch, 63½ miles long, supplies the new 4 million tons a year Shell refinery at Godorf and a refinery processing oil for Caltex at Wesseling; both these refineries are in Western Germany, south of Cologne. The second branch goes to Wesel, a distance of 28 miles, where it connects with an existing 16 in pipeline leading to Gelsenberg Benzin's refinery at Gelsenkirchen. There are pumping stations at Pernis and at Venlo on the Dutch-German border. To build the pipeline the company had to obtain over 500 licences from Government, provincial, municipal and other bodies, and negotiate for right of way with 2,500 landowners in Holland and Germany. Many underwater river crossings were involved, including the longest one in Europe, 5,580 ft, under the Hollands Diep, south of Rotterdam.



Europe's first international oil pipeline is 185 miles long. It will carry 8½ million tons of crude oil a year initially which may be increased to 20 millions by the addition of more pumping capacity.

On the Shelf

By Frank H. Smith

I AM irritated by that extension of the old school tie technique that persuades people to write "As a fellow member of Aslib I am writing to tell you that I sell so and so." Whether it is relevant to the activities of Aslib or not is beside the point. The phrasing savours too much of an attempt to ingratiate. If I were in sudden urgent need of the services of a firm such as might belong to Aslib I would ring Aslib and ask them who they had on the books. Even then, such is my perverse nature, I might not use the names they provided.

In the USA there is an American Society for Engineering Education (Urbana, Illinois). They it seems, sponsor an Engineering College Research Council to which belongs "every college of engineering with a significant research program." Each year they publish an *Engineering College Research Review*, the 1959 version of which is now ready at $2 per. This summarises the research being done in the member colleges: 10,000 projects, worth $112 million, in 118 institutions. Figures talk.

I was strolling through the Sits. Vac. columns of the *Times Lit. Sup.* (I do this occasionally to remind me that I am too old at 50) when I saw there was a job going in the Commonwealth Bureau of Helminthology. Quite. I didn't know either, so I looked it up in the Oxford and found that it is that branch of zoology, or of medical science, which treats of helminths. By now thoroughly aroused I chased the helminths to find they are worms, "esp. an intestinal worm." The job was for an abstractor. To use an inapt metaphor—not my cup of tea since even a cup of tea would turn to something else in *my* stomach if that were the sort of thing I dabbled in all day.

William Dawson (Cannon House, Macklin Street, London, WC2) have sent a specimen copy of an interesting Czech journal called *Technical Digest*, for which the subscription is £1 5*s* 0*d* a year. It is in English and the specimen (February) contains such articles as "A New system of reinforced concrete work without shuttering," "The project of a large new arch bridge in Czechoslovakia," "Flexible-element bearings combat self-excited rotor vibration," "Refrigerating semiconductor couples for direct energy conversion."

The thirteenth annual report of the Fire Offices' Committee, Fire Protection Association, lists some of the more expensive and appalling fires that occurred in 1959. I notice, too, a hint that quite a lot of smaller, household, fires have been due to the modern fashion for Do It Yourself. Among their publications the Association has a leaflet *Do-It-Yourself Safely* which, among other things, tells you where not to point a blowlamp.

I can hardly wait for that new Library of Science that they are going to start on the South Bank in 1963. If we put in applications for books now there is a fair chance that we'll be in at the start. I suppose some babe being born about now will be its first librarian. Poor little devil.

A leaflet is obtainable from D. F. Long and Company (Translations) Limited, of 17-18 Basinghall Street, London, EC2 (who have a "reputation for accuracy, speed and good literary style") describing their services in the translation field.

It is a bit of a let-down to receive an envelope bearing the words "An Invitation" only to find that instead of a glass of Tio Pepe at the end of it there is only an invitation to subscribe to '*pyridene and its derivatives*' in four parts. If Interscience think they'll get $150 out of me after all that they're mistaken. In any case I don't like dry sherry (which, of course, has no relevance to pyridine but is, if you remember, where we came in).

Competitive Technique

Mathematical Methods and Theory in Games, Programming, and Economics. By SAMUEL KARLIN. 2 volumes. *Addison-Wesley, Reading, Mass.; Pergamon Press, London.* (150*s*)

If managers, executives, and administrators know of the theory of games at all, their reactions to it are ambivalent. To see why this is so, we have to understand the function of abstract models in the application of mathematical techniques to physical problems. In the introduction to the work under review, the author said: "a model is a suitable abstraction of reality preserving the essential structure of the problem in such a way that its analysis affords insight into both the original concrete situation and other situations which have the same formal structure."

Engineers have been using models—in this abstract sense—for a long time. They have been assuming one-dimensional beams, forces attacking at a single point, frictionless joints "as a first approximation." Such models are useful, provided the answers to the problems they pose are sufficiently close to those which emerge from the real, physical tasks which they are meant to simulate. Only experience, that is practical observations and their realistic interpretation, can decide whether this is so or not.

In the theory of games we are concerned with decision problems. Although they must be as old as consciousness, their systematic study is of fairly recent origin. The aim is to make that decision which leads to the "best" outcome. Hence the value of any outcome must be expressible either quantitatively, or at least in terms of "better" or "worse."

In game theory in particular, we are concerned with situations whose outcomes do not depend on our own decision alone, but also on decisions of opponents, of "chance," or of "Nature." In this case a further criterion is required as to which decision is best. John von Neumann, who gave the theory its modern shape—though he had, of course, forerunners—introduced the Minimax Principle as the foundation of a pragmatic approach. This principle demands that of all possible decisions we choose that whose worst possible consequence is better, or at least not worse, than the worst possible consequence of any other decision.

On repeated trials it is often possible to improve the long-run average of the results by making random changes in one's decisions, rather than sticking to the same choice all the time. This procedure is useful to know as a practical guide. Clearly, it prevents your opponent from finding out what your decision is going to be, and from making use of this knowledge. But this possibility of "mixing" your choices has a consequence of great theoretical importance. Von Neumann has proved, for a prototype of games, namely for those where either of two players has only a finite number of decisions to choose from, and where one loses what the other wins, that both players can obtain the same value (positive for one, negative for the other) by using appropriate frequencies for their choices, while any other choice of frequencies might lead to a worse result for the player who chooses them. This is a result of great mathematical elegance, and by no means easy to establish. Many mathematical investigations, such as the work of Professor Karlin, were inspired by this result, and have led to extensions and to further developments, thus creating a new branch of mathematics. A technical description of some of the problems and methods for solving them was given in the reviewer's article "Theory of Games," published in ENGINEERING (vol. 185, 1958, p. 369.)

But what does this mean for practical applications? We find ourselves frequently in situations where the outcome does not depend exclusively on ourselves. But in order to make a model realistic, a great number of its features must be appropriate.

To begin with, chance, or Nature, do not behave in every respect as opponents do. Again, in economic competition, it is very rarely the case that two competitors have completely contradictory interests. A measure of cooperation is often conceivable, and of mutual advantage. A theory of such partly cooperative situations (in technical terms: non-zero-sum games) exists, and Martin Shubik, for instance, has made ingenious use of it in analysing market structure and competition. But this theory lacks the incisiveness of zero-sum (completely antagonistic) games theory, and its general applicability remains doubtful. Further, it is not easy to see the relevance of a long-run average made up of a series of random decisions, when only one single decision can be made under the circumstances. Finally, and fundamentally, one might not accept the soundness of the Minimax Principle. After all, there are gamblers, and many of them are successful.

Thus the theory of games is a conceptually attractive and intriguing background to situations of contest and competition, but it is difficult to think of a convincing example of its application which is not either over-simplified, or laboured. To a mathematician it remains a beautiful edifice of pure thought, irrespective of whether it is useful or not.

S. Karlin says in his preface that he has stressed most what appealed to him most. Naturally enough, these are mainly topics to which he has himself made distinguished contributions.

In part one of volume one, zero-sum games of the type described above are treated in a rigorous, abstract manner. Part two is entitled "Linear and Non-Linear Programming and Mathematical Economics." The problems dealt with here are those of optimal allocation of facilities in short supply. Linear programming is by now a well established branch of its own, with many ramifications, such as network theory. The book offers a glimpse of these relations. The connection with game theory is rather tenuous. Mathematically, linear programming is concerned with problems expressible by linear inequalities; the theoretical exploration of this field is also indebted to von Neumann, and to a number of other mathematicians. Non-linear programming is a development to problems where the relevant formulae, namely, those expressing constraints, and those of the benefit to be optimised, are not linear in the relevant variables. The latter usually express the level of an activity.

Cases of uncertain demand, and those where only integer values of the variables make sense, are briefly sketched, but these sections are by now mostly out-of-date. A mathematically interesting theory, due to Professors Kuhn and Tucker of Princeton, is exhibited, but its importance for computational algorithms is not further pursued.

Three chapters in this part of volume one are concerned with the study of economic models, such as the input-output analysis of Professor Leontief, with equilibrium problems, and with models of an expanding economy, due—once more—to John von Neumann. "The equilibrium relations for the laws of supply and demand reduce mathematically to certain systems of equations. The problem is then to establish the existence of economically meaningful solutions to the equations."

Volume two is entitled "The Theory of Infinite Games." This is a vast domain, parts of which have only been incompletely explored as yet. An infinite game is one where at least one of the players has an infinity of possible choices offered to him, for instance the choice of the precise time when to fire. The elegant simplicity of the theory of finite games does not carry over to these cases, and only some types of infinite games have been studied in any detail. They are characterised by some relatively simple feature

of the function which describes the dependence of the outcome on the choices of the players. This is the field in which S. Karlin has made most of his own contributions. The volume achieves a very high standard of mathematical rigour and interest.

The work is written with college undergraduates and post-graduates in mind. Many examples, exercises (mostly with solutions) and historical notes are attached. Some mathematical maturity is required for its enjoyment, but the reviewer believes that many readers of varied outlook can find many things of interest within its pages.

The two volumes contain the same bibliography, and each one has its own index. Paper, print, display of formulae and drawings are of the highest quality.

S. VAJDA

Automotive Statics and Dynamics

Mechanics of Road Vehicles. By W. STEEDS. *Iliffe.* (35*s*)

The author's aim in writing this new book is to cover in a single volume the principles of mechanics and certain problems that arise in the design of road vehicles. Few books contain this collected information in such a concise form.

The book is a useful addition to the subject of automobile engineering since it assembles in a comprehensive manner the basic technical information relating to the mechanics of road vehicles, with the exception of the engine. The author explains the reason for this omission on the grounds that a number of excellent books are already available on the subject.

An introduction to the book explains the fundamental principles applicable to the subject, and chapters covering forces in equilibrium, linear acceleration, rotational motion, torque relationships and gearboxes, vibration and springs, vehicle suspensions, brakes, some properties of pneumatic tyres, dynamics of a rigid body, directional stability, and transient motions of a vehicle. Also included is an excellent collection of examination questions and an index. For students requiring to study in greater detail the various subjects treated an adequate bibliography is provided. A large number of excellent diagrams and formulae are distributed through the text, amplifying and clarifying the technical matter. The author's style is easy and interesting to follow, particularly when one considers the very wide and complex nature of the subjects covered in this volume.

The chapter on brakes has brought together in a very compact form information which previously would have required the study of a number of papers and publications and provides the engineer with a useful working knowledge of the subject.

The behaviour of tyres which is covered in this volume should be of great assistance to the student or engineer who has not previously studied this aspect of road vehicles as it will enable him to understand the reasons for some of the essential design features of steering and suspension.

In treating a subject of this magnitude in so conveniently concise a book, it is impossible for the author to go into great detail on all the subjects, but the whole field of road vehicle mechanics is sufficiently covered. Mr. Steeds' textbook will be invaluable to draughtsmen and engineers engaged in this branch of engineering, providing a quick and ready reference to the principles involved of any part of the road vehicle, with the exception of the engine, which today is usually regarded as a very specialised section of road-vehicle engineering.

The author, who has written many books on technical subjects, is sufficiently well known that one can rely on the accuracy of the information provided. The book itself is excellently produced, the print being very easily read without occupying excessive space and thereby allowing a book of convenient size to be produced, especially when one considers the wide scope of the subject.

The book will provide considerable help to all students both of automobile and mechanical engineering who are working for their Ordinary or Higher National Certificate, or for the examinations of the appropriate professional institutions, and would be a very useful addition to the library of any engineer engaged or interested in these fields.

R. R. BISHOP

Subterranean Chemistry

Researches in Geochemistry. Edited by PHILIP HAUGE ABELSON. *John Wiley, New York; Chapman and Hall, London.* (88*s*)

Present-day geochemical research activity is the subject of this authoritative survey. It contains twenty-three essays on the development and present state of knowledge in different areas of geochemical research. These essays are the work of experts in the fields concerned, and each is provided with an extensive list of references. The essays were originally read before a seminar series held at the Geophysical Laboratory of the Carnegie Institution of Washington and the Johns Hopkins University in 1957 and 1958. The series was organised by the laboratory "as a contribution towards the alleviation of the situation" whereby, owing to the considerable increase of often only partly correlated geochemical research and the outpouring of new information in hundreds of diverse journals, "the earth scientists, both the professionals and those in training, can scarcely keep abreast with the developing frontier of geochemistry."

The topics chosen actually provide a very good cross-section of current research, and may roughly be classified as follows: (1) Four essays on nuclear geology: the use of tritium; oxygen; isotopes; sulphur isotopes; activation analysis (2) two on the geochemistry of organic matter, including oil genesis; (3) five on the chemistry of sedimentation and sedimentary materials: ocean floor; low-temperature reactions; distinction of marine from freshwater sediments; carbonates; minerals in Green River formation; (4) four on ore deposits: prospecting; original magmatic gas phase; environment of ore deposition; temperature of formation of ore minerals; (5) two on geochronology, including radiocarbon dating; (6) four on chemical processes and equilibria in, respectively, amphibole formation, metasomatism, metamorphosis and polymorphism at high pressures; (7) one on the composition of the earth; and (8) one on short-range ordering in layered sequences. The temptation to treat each of these excellent essays separately has to be resisted, because such is beyond the scope of the present review. Hence, only a representative selection is considered.

Reed draws attention to "Activation Analysis Applied to Geochemical Problems." This method, which has been given great impetus by the invention of the nuclear reactor (yielding a copious supply of neutrons), is very useful in measuring trace-element contents of materials because of its great sensitivity (greater than that of any other known method) and its freedom from contamination. Mention is made of applications to, *inter alia*, age determination and the problem of heat generation and loss by the earth.

The paper "Geochemistry of Organic Substances" by Abelson surveys the occurrence of the various constituents of organisms in sediments. Special mention should be made of the author's surprising detection of a variety of amino acids in shells as old as Devonian, and his considerations on the thermal stability of organic compounds.

Hanson's discussion of "Some Chemical Aspects of Petroleum Genesis" is mainly restricted to the problem of the chemical conversion of source material into crude oil. In contrast to the other papers, in which the authors' own contributions to the subject are incorporated, this paper is largely a literature survey. After a general introduction on the limiting conditions of petroleum formation—as arising from the natural occurrence and the chemical properties of oil—and the action of bacteria, reference is made to the important recent discoveries of differences in the composition of higher normal paraffins occurring in recent and ancient sediments and crude oils. The data available tend to indicate that crude oil is not formed in recent sediments. The author infers that it must be generated at some greater depth, from source material other than the hydrocarbons generated by organisms, such as lipids and proteins. Possible reaction mechanisms are discussed. No attention is given to loci of accumulation of these materials and other burning questions such as the relation between gas and oil generation and the generation of different types of oil.

Milton and Eugster's paper on minerals in the Green River formation will probably evoke wide interest because many new minerals indigenous to the Green River formation have been found in this bituminous deposit (oil shale!). The origin and nature of the Green River formation are outlined, after which the uncommon mineralogy and its origin are discussed by means of phase diagrams and possible reaction mechanism, taking into account the special conditions of sedimentation and diagenesis of the formation.

Another interesting paper on the chemistry of sedimentary materials is that by Goldsmith on the "Geochemistry of Carbonates." A detailed discussion is given of equilibrium relations in carbonates as related to composition and crystal chemistry. Noteworthy is the passage on "the dolomite problem," the crux of which has to do with the failure directly to precipitate dolomite in the laboratory from solutions at room temperature, and thus with the formation of dolomite in sediments.

Goldsmith refers to experiments in which dolomite was ultimately produced from a variety of starting materials, but hydrothermal treatment appeared to be necessary to convert the first gel-like carbonate precipitates into ordered dolomite. On this, Goldsmith bases the intriguing statement: "There would probably be no 'dolomite problem' if sedimentary phenomena took place at higher temperatures than they do"!

The paper by Kullerud on "Sulfide Systems as Geologic Thermometers" proves the economic interest of theoretical studies of temperature-pressure relationships and phase diagrams of ore minerals. From the temperature of formation of ore minerals, temperature gradients in the ore

Continued on next page

deposits may be derived which indicate the direction of flow of the mother solutions or gases, and thus indicate the probable continuation of ore veins. Reference is made to Kullerud's finding a temperature variation of 90° C over a vertical distance of 300 ft in an ore deposit in the Breckenridge area in Colorado. This discovery, together with additional temperature data, indicates upward movement of the mother solutions along fault fissures in the monzonitic host rock, thus refuting earlier views that the ores would not continue at depth.

This paper, like several others such as those on amphibole formation, metasomatism, etc., illustrates how far theoretical chemistry has pentrated into geochemistry and how far geochemistry has developed from the initial phase of gathering data on the abundance and distribution of elements in rocks. More than an elementary knowledge of chemistry is required in order to read these latter papers, because they are largely based on thermodynamic, phase rule and equilibrium considerations.

The omission of other important subjects such as the origin and transformation of clay minerals must be attributed to the limited time and space available, and does not detract at all from the value of the book. The excellent treatment of the diversity of topics makes it an authoritative contribution to geochemical literature which should be in every geological library.

The book is well presented, and the illustrations and diagrams are clear and easy to read. It is highly recommended to geochemists, and also to anybody who is interested in progress in this borderland between chemistry and geology and does not shrink from tackling some chemistry.

W. G. ALDERSHOFF

Protective Covering

Organic Coatings. By RAYMOND B SEYMOUR. *Reinhold, New York; Chapman and Hall, London.* (60*s*)

Addressed to the paint and coating technologist this is a competent textbook on the subject of coatings which involve the use of heat in their application. It is not a general guide to the engineer on protective coatings and indeed, much that is contained within this book may well be outside the knowledge and experience of many civil or mechanical engineers. The book is lucidly written and as a textbook is completely free from written irrelevant matter. Some of the illustrations seemed to the reviewer to be a little pointless but the section on pipe lining, internal and external, will be of interest to many British pipeline engineers, for coating techniques are not so well developed in this country. The book is packed with valuable tables to workers in this field.

There is a very desirable trend at the present time to specify coatings, using this term to mean materials giving higher builds than paints, by their film thickness. When this is done, it is important to be able to establish the covering capacity of any coating in square feet at a given thickness. Contained within this book, there is a table giving the solids percentage by volume against the film thickness in mils when one gallon is used to cover 100 square feet. The table is later reversed quoting solids percentage by volume against the area covered in square feet at 5 mils thick. Even this table, however, will be of more value to the contractor undertaking coating work than to the engineer.

The book is provided with an excellent index and while no separate bibliography is included, there are within the text adequate bibliographical references. The author mentions most of the traditional surface coatings, particularly pitches, asphalts and bitumens but additional chapters deal also with hot melt applications without solvent, such as peel coatings, flame spraying and the fluidised-bed process.

MARK WAGHORN

New Books

Modern Air Conditioning, Heating and Ventilating. By WILLIS H. CARRIER, REALTO E. CHERNE, WALTER A. GRANT and WILLIAM H. ROBERTS. 3rd Edition. *Pitman, New York and London.* (80*s*)

Written by members of a pioneer US company in air conditioning, this book has been designed to apply existing theory to actual practice in industry. The new edition incorporates new material and revision, in particular, of material on heat pumps, air condensers, water treatment, high-velocity air duct design, and air cleaning.

Handbook of Chemistry and Physics. 41st edition. Edited by CHARLES D. HODGMAN. *Chemical Rubber Publishing Co., 2310 Superior Avenue, Cleveland, Ohio.* ($12·50)

Nearly 3,500 pages on mathematical tables, properties and physical constants, general chemical tables, specific gravity and properties of matter, heat, hygrometric and barometric tables, sound, electricity and magnetism, light, quantities and units.

Admiralty Working Party on Gearing: Memorandum on Precision Gearing for Control Systems and Armaments. Part 1. *HM Stationery Office.* (17*s*. 6*d*)

A design handbook for machine cut or ground spur helical and crossed helical gears of the 20° full depth involute system, with profuse tables and diagrams.

The Theory of Numbers and Diophantine Analysis. By ROBERT D. CARMICHAEL. *Dover Publications, New York; Constable, London.* (11*s*)

A facsimile reprint of two books originally published in 1914 and 1915 respectively.

Ship-Machinery, 1960. *The Ship-Machinery Manufacturers' Association of Japan, 2 Kanda Tsukasacho 2-chome, Chiyoda-ku, Tokyo, Japan. (Free of charge)*

A well-produced volume made up of an introductory account of Japan's shipbuilding industry, followed by a classified section of illustrated manufacturers' announcements, and a directory of manufacturers and organisations connected with shipbuilding.

The Corporation of the Borough and Foreign of Walsall. By ERNEST JAMES HOMESHAW. *Published for the Council of the County Borough of Walsall by the Press of Geof. J. Clark Ltd., 183 High Street, Bloxwich, Walsall, Staffs.* (25*s*)

A history of the 208 years life of the Corporation, from its charter in 1627 until its reconstruction in 1835, written chiefly from uncalendared documents in the Council's possession. Coal and iron working and numerous smithies in and around Walsall were reported in 1540, and in 1680 extensive metalworking in tough iron from Rushall, Swedish copper and Cornish tin. This specialisation was maintained in the early part of the 19th century, when the 83 platers then at work were second only to the 109 innkeepers in numbers of trades and professions.

Data Book for Civil Engineers. By ELWYN E. SEELYE. Volume 1: Design. 3rd Edition. *Wiley, New York; Chapman and Hall, London.* (192*s*)

The first volume of a three-volume series intended to provide a concentrated collection of the data necessary to design, place under contract, and construct all types of civil engineering structures.

Eighth International Towing Tank Conference, Madrid, September, 1957: Proceedings. Edited by M. L. ACEVEDO and L. MAZARREDO. *Canal de Experiencias Hidrodinamicas, El Pardo-Madrid.* (600 *pesetas*)

Sessions were held on scale effects on propellers, skin friction and turbulence stimulation, comparative cavitation tests of propellers, seagoing qualities of ships, and forces and moments on ships in a seaway.

Rectification Superfinition. By F. HENRY and H. POURET. *Editions Eyrolles, 61 boulevard Saint-Germain, Paris 5.* (23·30 *NFrs*)

Equipment and practice of milling, grinding, finishing and polishing, illustrated with diagrams, photographs of machine details, and micrographs of surfaces.

The Reviewers

Dr. S. Vajda is engaged in mathematical research at the Admiralty Research Laboratory, Teddington, and has published several papers and other works on theory of games and on mathematical programming. He is a Member of Council of the Royal Statistical Society.

Mr. Roland R. Bishop, M.I.Mech.E., has recently retired from Vauxhall Motors Limited, where he was commercial vehicle engineer. Previously, he had been chief draughtsman with the same company and with Bentley Motors Limited. From 1929 to 1930 he served with Associated Transmissions Limited as chief designer in the development of the Barrington inertia gear for use in road vehicles and the Humphrey Sandberg free wheel, and earlier had worked with G. Constantinesco, on carburettors, W. H. Dorman and Sons, the Admiralty and D. Napier and Sons.

Mr. W. G. Aldershoff is a chemist employed by the Bataafse Internationale Petroleum Mij., The Hague, Holland.

Mr. Mark Waghorn is a director of E. and F. Richardson Limited and is particularly concerned with the company's Industrial Protection Division.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical

Voltage Regulators. CLAUDE LYONS LTD., Valley Works, Hoddesdon, Herts. Automatic voltage regulators and stabilisers in a wide range of standard units. Illustrated catalogue.

Cable Trunking. LANCASHIRE DYNAMO NEVELIN LTD., Hurst Green, Oxted, Surrey. The Neviduct system of cable trunking is described in a leaflet.

House Wiring. MK ELECTRIC LTD., Shrubbery Road, Edmonton, London, N9. Suggestions for house wiring and lists of appliances likely to be used in each room. Booklet.

Home Installation. J. A. CRABTREE & CO. LTD., Lincoln Works, Walsall, Staffs. Booklet "Design for Living," covers all points for home installations; there are diagrams of all rooms with recommended spots for sockets. Illustrations are in colour.

Crane Motors. LANCASHIRE DYNAMO AND CRYPTO LTD., Trafford Park, Manchester 17. Examples of motors for various types of cranes and hoists. Illustrated folder ML88.

Variac Regulators. CLAUDE LYONS LTD., Valley Works, Ware Road, Hoddesdon, Herts. Particulars of the full range of some 200 Variac autotransformer regulators are given in catalogue V599.

Lighting Fittings. TROUGHTON AND YOUNG (LIGHTING) LTD., 143 Knightsbridge, London, SW1. General purpose ceiling lighting fittings are described in an illustrated leaflet.

Illuminated Ceiling. A.E.I. LAMP AND LIGHTING CO. LTD., 4 Fitzroy Road, London, NW1. Isora illuminated ceilings described in illustrated brochure.

Marketing

£1½ Million Press Order Announced at Tool Show

An order for 27 presses by the Ford Motor Company in Britain from Danly Machine Specialities Incorporated, of Chicago and London, was announced in the closing days of the Olympia machine tool exhibition.

Harland and Wolff will, as on previous occasions, manufacture the presses at their Scotstoun works as subcontractors, working to designs from the Chicago office.

The 27 presses are worth about £1½ million. Four of them are Danly series D double action presses with an inner slide capacity of 700 tons. The other 23 are single action machines, 19 of them of 800 tons capacity and 4 of 400 tons.

Danly have so far supplied 22 presses to Ford's and another nine are now being built. Delivery of the new order is to begin in the third quarter of next year and end in the fourth of 1962.

The company made the announcement, with its UK agents Gaston E. Marbaix, while making their first showing at Olympia of complete Danly presses.

The four double action presses have two-speed clutches which allow for a quicker release movement and increases the amount of time in which the presses are directly working.

On the continent MAN manufacture Danly machines.

An American at the Machine Tool Exhibition

One of the most determined visitors to the Olympia machine tool exhibition was Mr. Peter Onderchain, consultant on manufacturing equipment and processes for the General Electric Company of Schenectady, New York, USA.

Mr. Onderchain came to London with some very big questions in his mind. High among his priorities was a $25 million new factory for the manufacture of heavy electrical plant for which International General Electric have already broken the ground 40 miles from Sao Paulo in Brazil.

The basic reason for this step is that the Brazilian Government want the equipment for the electricity generating industry to be made in their own country, with the natural effects on the country's wealth, and not simply imported.

The machine tools bill that Mr. Onderchain and his colleagues will be compiling for this important new works is estimated to be in the region of $8,237,000. The vast machines of the Schenectady works will not all be appearing in the first version of the Brazilian factory at Campinas. Later developments, if the turnover will bear them, will bring the heaviest machines to the 168 acre site.

For all that, Mr. Onderchain's shopping list includes such costly products as engine lathes with 35 ft between centres and able to support a load of 100 tons between centres.

His view of the exhibition is not easy to summarise but it was not exactly encouraging. The demands of engineering for the space programme in the United States have carried much of their metal forming practice into another age than that on view at Olympia.

"An often excellent exposition of metal removal," was the overall view of Mr. Onderchain, whose own engineering problems, whether in jet engines or important parts in electric generating equipment, turn more and more on extrusion.

GE's consultant did find an automatic circular fine boring machine more accurate than anything he has found in his world travels. This is manufactured by the Gear Grinding Company, of Solihull, Warwickshire, and is one of the discoveries at Olympia which General Electric will be actively following up.

Elsewhere in his long hours of detailed inspection Mr. Onderchain unearthed important ways of meeting particular problems and will in fact be considering quotations from a number of machine tool manufacturers.

Storage Heaters Beating the Squeeze

The storage heater draws on its economic advantages and appears to be able to withstand the depressing effects of stricter hire purchase. In April, although refrigerator sales by the electricity boards were less than 1 per cent down on those of a year ago, and cookers almost 3 per cent down, washing machine sales had declined by more than a quarter. By the same comparison storage heaters were selling 20 per cent better than a year ago.

This is particularly helpful to the General Electric Company and others who produce storage heaters in addition to appliances cut down by the anti-inflation measures.

As an obvious money saver the storage heater can be expected to sell well when money is costly and any saving is worth making, and also to prosper when money is easier and spending on equipment can be more easily approved.

Two Hundred AEI Motors for Spencer Mill

Richard Thomas and Baldwin's Spencer Works, near Newport, Monmouthshire, is to have its heavy duty cranes driven by more than 200 d.c. motors. The order for the motors has been placed with Associated Electrical Industries' motor and control gear division by the consultants, the International Construction Company.

The materials handling cranes will vary between 15 and 200 tons capacity.

Yugoslav £3¼ Million Order from Massey-Ferguson

The increasing pace of United Kingdom agricultural machinery exports has been quickened by orders from Yugoslavia placed with Massey-Ferguson that include almost 6,000 tractors.

The Yugoslav orders, which came through Industrija Traktora I Masina, are worth £3¼ million. The tractors, and implements worth over £600,000, are all to be delivered by the end of the year.

Fulfilment of the agreement will carry the total Massey-Ferguson equipment bought by Yugoslavia since 1955 to more than £21 million.

With their recent order from Brazil for 1,000 tractors, Massey-Ferguson are able to survey an increasingly satisfactory export order book.

Increasing in the first five months of the year by 28 per cent over the same months of last year, the exports of British produced agricultural equipment are well up among the industries accounting for the increased value of manufactured exports so far this year.

British Made Springs for American Fords

Four thousand leaf springs a week are to be sent to the Ford Motor Company, Detroit, by Toledo Woodhead Springs.

The contract, believed to be the first such major long-term agreement with the United States car industry, runs for two years and is worth around £500,000.

Clearly a cost cutting step by the American industry, the Ford executives considered offers from Germany and France among other European countries before signing with Toledo.

After the first three months the order may be doubled.

The costs of transport and the relatively small part of the total cost taken up by the leaf springs suggest that the cost saving achieved by going to the Darlington and Sheffield factories for Toledo's springs should not have any serious effect in the price war between United States built and imported cars.

Curious Citation for TI at New York

Tube Investments, with the Worshipful Company of Goldsmiths, were joint winners of the contest for the best designed display at the New York British trade fair.

The contest judging team cited the TI New York efforts as outstanding for "interesting use of less dramatic subject matter." It is no reflection to the other stands to say that on the face of it the judges came to a laudable decision, but if they think that TI affairs are undramatic they cannot have come across Sir Ivan Stedeford nor, presumably, have they absorbed very much of the information on what TI can do with tubes.

First Guided Missile Destroyer Launched

The Royal Navy's first guided missile destroyer, HMS Devonshire, was launched by Princess Alexandra from the Cammell Laird Shipyard at Birkenhead last month. The Devonshire was laid down in March, 1959, and is expected to take her place as a County class destroyer by early 1962. The sister ships, Hampshire, Kent and London, should all have entered service by the spring of 1963.

The Devonshire is armed with a Seaslug guided weapon system mounted on the quarterdeck, four radar controlled 4·5 in guns in twin mountings forward and two Seacat close range guided weapon systems fitted abaft the after funnel.

She will also carry a Westland Wessex helicopter, the first fitted out as a complete submarine killer.

The machinery is a completely new type. For normal steaming there are two sets of geared steam turbines. For high speeds and getting quickly underway there are gas-turbines. Associated Electrical Industries (Manchester) designed the steam turbines and are building one set of the machinery. Cammell Laird are building the other. AEI designed and are building the gas-turbines.

The Growing French Tanker Fleet

Tanker tonnage may be one of the points where the world's shipbuilding has been most overdone, but evidently there are forces at work that have not yet abated.

The French are building up a tanker fleet one of whose characteristics is the great size of the units. Six tankers, each of more than 70,000 tons, are being built in the French shipyards and the first was recently launched by Chantiers de France.

The tanker, to sail under the Liberian flag, is the J. Paul Getty, 72,600 tons, and she is the largest tanker so far built in Europe. This is a record that will not stand for long.

Chantiers de France are busy building a number of large tankers; with those on order, the total is eleven. They range in size from 40,000 to 77,750 tons.

£3 Million Extension by Tube Firm

The capacity for ball bearing and other heavy duty alloy steel tube output of Tubes Limited, the Desford, Leicestershire, subsidiary of Tube Investments Limited, is to be doubled by the TI scheme to spend £3 million on its extension.

The preparatory work on the project is already in hand.

Tubes Limited, which has the only plant of its kind in Europe, exports part of its output. The new mill to be built will make use of a number of technical developments.

Industrial Production in First Five Months

Unofficial reports suggest that, certain types of more vulnerable consumer goods apart, industrial activity has not yet suffered any marked decline after the recent Bank Rate imposition.

Treasury figures for May, before the dearer-money stick came down with full force, show the index of industrial production running at 124 to 125, thirteen or fourteen points above the index of 111 for May, 1959.

For the first five months of 1960 the index had an average of 120, eleven points higher than the corresponding 1959 average.

Cheaper AEI Silicon Controlled Rectifiers

Associated Electrical Industries' electronic apparatus division, the first manufacturers in Europe of silicon controlled rectifiers on a commercial basis, have reduced their price by between 10 and 30 per cent.

The Lincoln works of AEI commenced production of the rectifiers only in January. There are two current ratings at present in the AEI rectifiers—5 amps and 10 amps, with a voltage range in each case from 25 to 300.

Points of Interest in Cableway Headcars

Cableways are commonly used today in dam construction. The heart and brains of a cableway lie in the headcar which also forms a travelling anchorage for the track rope. It is a very unusual special purpose machine, different for each application.

THE construction of a dam across the Sefid Roud River in northern Iran is one of the major projects included in the Iran Government's Seven Year Plan, and is the central feature of an important hydro-electric scheme. The dam, outside the town of Manjil about 180 miles from Teheran, is due for completion in 1961.

Main contractors are a consortium of three French companies known as SASER, who chose British Ropeway Engineering Company Limited of London, EC3, to supply and install the three 2,000 ft long radial cableways employed in the dam construction. The dam spans a narrow gorge which is subject to severe winds throughout most of the year. Wind conditions greatly influenced the design of the cableways, in particular the headcars, one of which is shown in Fig. 1.

Each headcar forms a travelling anchorage for one end of the track rope; it houses the main cableway machinery and control gear, and also mounts the operator's cabin and rope sheaves. The other end of the track rope is attached to a fixed tailmast. The three headcars run on a common rail track built on a shelf cut in the high ground above the west end of the dam. The track follows an arc of a circle with centre at the tail-mast to preserve the tension in the track rope, and this is shown in Fig. 2 illustrating two of the headcars in operation. All the material for the entire cableways was designed, manufactured and delivered within nine months of the order.

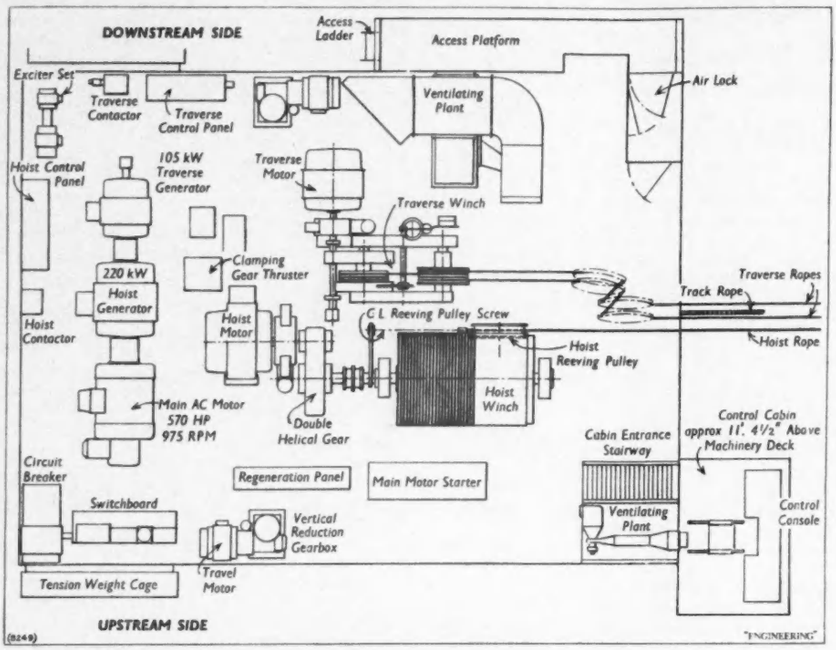
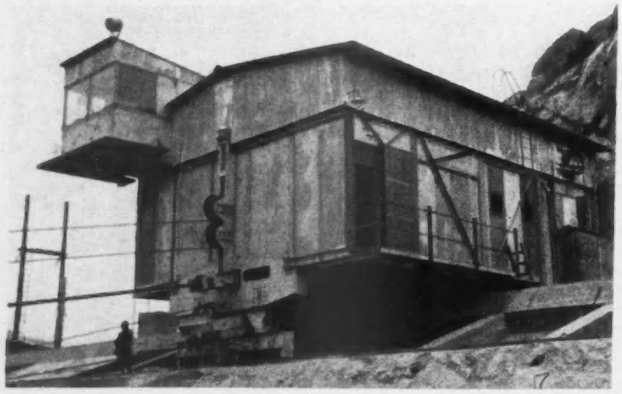


Fig. 3 Plan of machinery layout inside headcar.



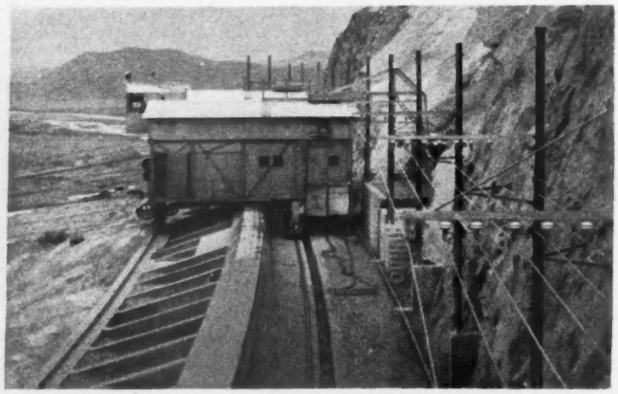


Fig. 1 (above left). Front of headcar showing front rail bogies, traverse pulleys, anchorage for track rope and control cabin.

Fig. 2 (above right) Two headcars side by side showing rail track, thrust rail and supply pick-up.

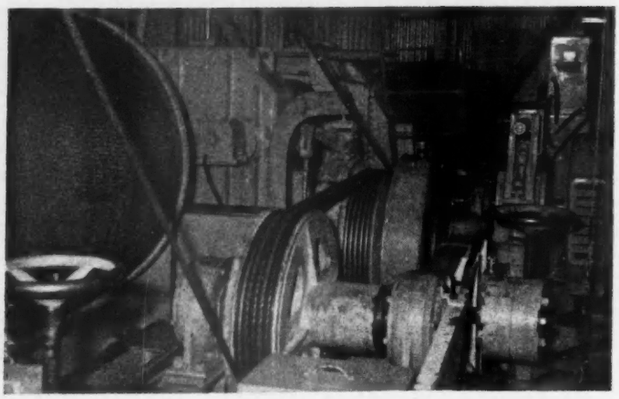


Fig. 4 (right) Some of the machinery in the winch house showing (left) the hoist drum and (centre) the traverse winch.

Leading Particulars

Cableway type	BRECo. Two Motor
Cableway capacity	10·8 tons
Total span	1,990 ft
Working span	1,400 ft
Track rope diameter	2½ in
Track rope breaking strength	350 tons
Height of headcar (rail to track rope connection)	6 ft 6 in
Hoisting speed (full load)	4·6 ft per sec
Lowering speed (full load)	6·6 ft per sec
Loadcar traversing speed	20 ft per sec
Headcar travelling speed	32·8 ft per min
D.c. hoist motor	275 b.h.p. at 600 r.p.m.
D.c. traverse motor	130 b.h.p. at 600 r.p.m.
A.c. headcar travel motors	(2)20 b.h.p. at 705 r.p.m.

Headcar description

Each headcar consists of a steel framed structure with its sides, roof and floor clad with flat corrugated steel sheets. It comprises a winch house containing all the machinery and electrical gear, with a control cabin mounted high up at the front and offset to one side. The large sheaves for traversing the loadcar also protrude at the front. To prevent any ingress of the sand prevalent in that region, the air within the headcar is slightly pressurised by the ventilating system.

The headcar is supported in the vertical plane

by two sets of rail wheels, one set at the rear and one at the front, the track gauge being 25 ft 6 in. The horizontal thrust from the tension in all the ropes is taken by eight horizontally-mounted wheels engaging a track rail fixed to the vertical face of a concrete buttressed wall.

Access ladders and platforms are provided for maintenance purposes. The winch house is entered from ground level through double doors which form an air lock. Access to the control cabin is via a stairway from the winch house.

Hoisting Gear

The hoist winch is of the single-drum full coiling type, one end of the hoist rope being anchored to the grooved drum. In order to keep down the overall width of the headcar and yet permit an optimum arrangement for the other winch house equipment, the unusual step was taken of positioning the hoist drum with its centre-line parallel to the track ropes. Fig. 3 shows the layout, and Fig. 4 the drum itself and the traverse winch. The hoist rope leaves the drum vertically downwards, and to ensure perfect rope lead a sheave is provided below. This is mounted on a saddle free to slide along guide bars in sympathy with the grooves on the drum. Axial movement is provided by a square-threaded screw fixed to the saddle, which engages a nut driven from the drum shaft by means of a duplex chain drive.

The 275 b.h.p. Crompton Parkinson hoist motor drives through totally enclosed double helical reduction gears. A coupling between the motor and gears is used as a brake path for the operational electromechanical thruster brake. An emergency brake path is fitted to the flange of the hoist drum. This brake is weight-operated and is tripped by hand from the control cabin, being reset locally by means of a handwheel.

Traversing Gear

The traversing gear is for the purpose of moving the loadcar along the track rope as opposed to travelling the headcar itself.

The traverse winch is of the double-drum endless rope type, each drum being fitted with Walker rings to take up rope stretch. One drum is an idler and is used to feed the rope from one Walker ring to the next on the driving drum. The 130 b.h.p. traverse motor is by Crompton Parkinson, and the reduction gearing, and operational and emergency brakes are all similar to those on the hoist winch.

Travelling arrangements

The rear of each headcar is carried by two rail wheels, while a pair of two-wheeled bogies carry the front. Travel drive is taken to four of the eight horizontal thrust wheels, which are mounted in four two-wheeled bogies. The two 20 b.h.p. Crompton Parkinson motors drive the wheels through reduction gearing totally enclosed in oil baths. Primary worm reduction units are coupled to the travelling motors, the coupling forming the brake for the travel motion. Drive to the spur gears on the bogies is via universal coupling shafts.

To restrict the travel of the headcars along the track and to prevent them from colliding, each is fitted with limit switches which cut the supply to the motors and apply the thruster brakes.

Clamping gear

Each headcar is provided with a set of clamping gear acting on the rear track rail, to provide anchorage in any desired position on the track. It is weight-applied and released by an electro-hydraulic thruster, operated either automatically by the travel control gear, or by a push button in the control cabin. It consists of two toggle-operated clamping arms connected by means of a yoke which rests on the rail head when the clamp is in operation.

Fixed Rope Connections

Apart from the track rope, which has a pin ended connection on the front framework of the headcar, two " button " ropes are provided. Their purpose is to space the slack rope carriers as the loadcar traverses in either direction. Unlike the track rope, the button ropes each have a weighted tensioning device at the headcar end. The tensioning device for the track rope is at the tailmast.

VENTILATING SYSTEM

Air pressure in the winch house and control cabin is kept a little above atmospheric, all air being drawn in through sand traps and oil-wetted filter cells before entering the centrifugal fan. Thence it is fed into the headcar under pressure via a system of ducting. The control gear is so arranged that power is not available for any purpose except the travel drive unless the ventilating fan is operating. There is separate equipment for winch house and cabin, all supplied by Visco Engineering Company Limited of Croydon, Surrey.

Each headcar is well insulated, and heaters are provided for warming the incoming air when required. The front and sides of the control cabin are fitted with double glazing. Both cabin and winch house are double roofed.

Electrical Equipment and Controls

Almost 1,500 h.p. of electric motors and generators are installed in each headcar, all of Crompton Parkinson Limited manufacture.

A current collector set supplied by BICC receives a 380V 3 phase 50 cycle supply from the local diesel-operated power station via overhead collector wires, and passes it to the main switchboard in the winch house. The switchboard feeds a main Ward-Leonard driving motor of 570 b.h.p. at 975 r.p.m., driving a 220 kW hoist generator, 105 kW traverse generator and a d.c. exciter with its drive motor. A separate 800 amp circuit breaker is provided for the main drive motor, supplied by George Ellison Limited of Perry Barr, Birmingham.

An automatic regeneration panel with loading resistances is provided to absorb the generated power from the hoist and traverse motions when the load is overhauling. There is also special provision for limiting the current peaks to a level which will not embarrass the generating capacity of the local power station.

An interesting feature of the electrical equipment is a 3-field system of Ward Leonard control applied to the generators for the hoist and travel winch motors. The 3-field generators have, of course, been used for some time for drives in which slow speed control is not essential, but this system, in which two degrees of series field control are provided, is believed to be the first of its kind. This provision is to give stable control at low speeds, independent of the magnitude and direction of the loads imposed.

In this system the series field is split into two portions, and the control is arranged so that for slow speeds, corresponding to the first four positions, of the controller, only one part of the field is in circuit. The remainder of the control uses the full field. The values of the two portions of the series field are so arranged that current is restricted to a maximum of approximately twice full load current even if the controller handle is thrown quickly to position 4 with the motor stationary. This arrangement gives a much finer slow speed full load control. It is not necessary to break the series field circuit when moving the controller above position 4, bringing both portions of the field into operation, as a " make before break" contactor is used.

All control gear for the motors and generating sets was made by the Electrical Apparatus Company Limited of New Barnes Avenue, St. Albans, Hertfordshire, in collaboration with British Ropeway Engineering Company Limited. All cableway operations are controlled from the console in the control cabin.

Do-it-Yourself Teaching Machine

An automatic teaching machine known as the Auto-Tutor has just been introduced into this country. It can instruct anyone on virtually any subject, ranging from bridge or golf to complex electronic problems or abstruse mathematical formulae, and is claimed to be the first machine to achieve the teaching function through integrated student participation. Initially its most likely use will be in large industrial and military training programmes.

The tutor presents questions on any chosen subject to the student. If he answers correctly, the machine congratulates him and sets him a further task. If he is wrong, the machine tells him how and why, and encourages him to tackle the problem again after giving further information. Thus the tutor can assess real knowledge and rate of progress, so that the true educational level of the student is revealed. Its chief advantages are that it treats the student as an intelligent human being, advances him at a rate determined by his own ability, frees the teacher for creative work, and provides a record of the student's progress and his individual approach and reasoning process.

In principle the machine is an automated " reader " that locates and presents any selected subject image or images on a viewing screen when a number is punched on its keyboard. The student controls it by pressing combinations of buttons (which total 40), according to which answer he chooses. Each alternative answer shows a new image number alongside it, then the tutor automatically locates and presents a new image. Thus the microfilm may be ordered to go forward or back to any one of 9,999 numbers corresponding to images on the microfilm.

Since the machine develops knowledge of the subject matter step-by-step at the student's own pace, it makes sure that each point has been grasped completely, and develops his knowledge in a logical manner based on what he has learnt.

Due to a combination of still and motion picture capabilities, the tutor can instruct either by means of photographed printed material, or by actual demonstrations in motion. The student's progress record is printed on paper tape, which contains a step-by-step history of the sequence of images chosen and the time he spends in dealing with each image.

The auto-tutor was devised by the Western Design Division of US Industries Incorporated, USA, and it was shown at the recent Electronics Exhibition in London by their British company. It is expected to cost between £1,000 and £4,000 and standard or special courses will be available.

The Auto-Tutor in use. Images appear on the viewing screen to the left of the cabinet, and on the right is the selector keyboard with numbered buttons. The progress recorder is on top of the cabinet.

Drive Shafts for Tomorrow's Larger Car

Following last week's review of future drive-shaft requirements for smaller cars, the author foresees a trend in larger cars towards independent rear suspension, with front engine, and the transmission components grouped together in a single rear unit.

By John Rabson, A.M.I.Mech.E., M.S.A.E.

IN last week's article on the development of drive shafts, only small cars were considered, yet the picture is also one of change so far as larger cars are concerned. Although they will develop on slightly different lines, they will to some extent be influenced by what takes place with the smaller cars.

Previously it has been suggested that the trend in drive shafts for small cars will be towards a combination of constant velocity and rubber joints, and that for cars of up to 1½ litres the conventional propeller shaft using Hooke's joints will tend to disappear. What of the larger cars, and how will this trend affect them? It is likely that a number of changes will take place, and they will take place for a variety of reasons—reasons that will have a much greater significance than a purely backroom desire for technical advance. Nor is any one factor likely to dominate.

If in thought we project a little to a time when all of our small cars have independent suspension on all four wheels—this is a logical trend already taking place in both front and rear engined small cars of modern design—it is unlikely that the driver who becomes accustomed to the standard of comfort and handling that exists with the best examples of small independently sprung (front wheel drive) small cars of today will be content with a less advanced car in terms of handling and comfort when he graduates to a larger and more costly model. In fact, for the higher price that he pays he will rightly expect something better; this is one reason for suggesting increased use of independent rear suspension. There are other factors, too, and assuming that the larger cars have the engine at the front, and drive on the rear wheels, one reason for adopting independent rear suspension could be to increase the body space, particularly for the rear passengers. This is brought about by eliminating the bump clearance necessary over the rear axle on a conventional Hotchkiss drive. At the same time the central propeller shaft tunnel can also be reduced.

The use of this layout could be adopted with very little change, except that one propeller shaft and two half shafts are replaced by *three* more or less conventional propeller shafts, as for example the drive on the Triumph Herald shown above. (The only difference is that in this car the propeller shaft has sealed bearings and does not require routine lubrication at frequent intervals.) Up to seven universal joints could be used per car—three for the divided fore-and-aft shaft and two each per drive shaft.

In such a competitive industry, it is unlikely that the multiplication of joints would be readily accepted, and an examination of possible alternatives may indicate that this view is fully justified. The functions of the shafts differ, in that the fore-and-aft shaft, with a front engine, rear-wheel drive and fixed (sprung) differential, is not required to operate at varying angles depending on the position of the road wheels in relation to the car. It is more likely to be required to operate at a small fixed angle, because of the rearward inclination of the power unit to lower the drive line and reduce the size of the gearbox hump in the front compartment.

If development is taken one stage further and all the torque multiplying components are grouped with the differential, the range of torque that is transmitted through the shaft is further reduced, and it may be possible to make that component even smaller and lighter.

On grounds of economy a cheaper coupling might be contemplated; perhaps a modern equivalent of the disc coupling that preceded the needle roller universal joint, but taking advantage of new materials that are now available. In so doing it might also be possible to provide further torsional flexibility, and interruption of the mechanical noise path. For this shaft a simple splined attachment to the gearbox output shaft (or input if it is at the rear) should permit the required assembly tolerances to be taken care of, and also simplify assembly. One disadvantage with non-metallic couplings is that they are usually larger in diameter than their metallic equivalent.

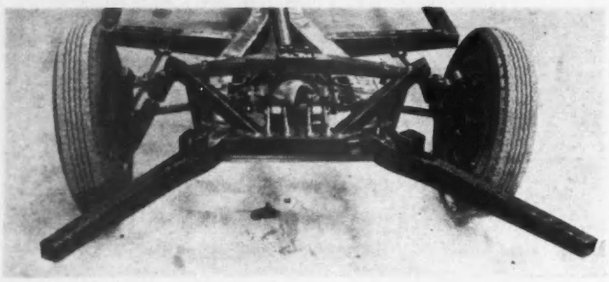
For the final drive shafts (differential to road wheels) the choice of joint will depend to some extent on the layout adopted, and any number from one to four universal joints may be required. An example of the single universal joint system is the Mercedes-Benz swing axle illustrated above. Compared with a fore-and-aft shaft, the drive shafts must operate at a larger and changing angle, and transmit a higher torque, with a corresponding reduction in speed of rotation. They are also exposed to mud and water to a greater extent, and if inboard brakes are used they will have to transmit braking as well as driving torque. With the lower operating speed, balance problems are less difficult, while if mechanical joints are used they should be well sealed. With some systems there could be a temperature problem if the joints are very close to the brakes. If inboard brakes are used it is probable that metallic joints would be favoured, although the effect of heavy braking via a torsionally flexible system such as a drive shaft containing one or more rubber joints requires further investigation before final decision.

Although constant-velocity joints are not yet considered essential for rear-drive shafts, they would be preferred, if they could be supplied at no greater cost. For certain systems the ideal might be a constant-velocity non-metallic and torsionally flexible joint.

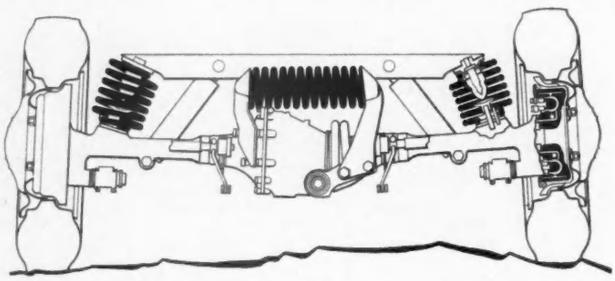
For applications requiring both a universal joint and a sliding spline, one obvious line of development would be to combine these two units into one joint. Within their limitations, joints of this sort do provide a solution in certain cases. One example was adopted several years ago by Rolls-Royce on their three-joint propeller shaft, used with a conventional Hotchkiss drive layout, to overcome spline friction. If it is decided that the most economical way of eliminating spline friction is to eliminate the spline shaft, this also may affect the detail design even if conventional Hooke's joints are used. For example, if the drive shaft is to form part of the suspension system of a rear-wheel drive vehicle, the component must also withstand suspension loads and cornering forces.

Little has been said so far about the really large commercial vehicles, and here again the constant-velocity joint is likely to find favour. First, with large vehicles, often having complicated drive lines, the greater freedom of joint angle provided by constant velocity joints would simplify the installation. Further, even if it is possible to obtain uniform angles at both the input and output ends of a large shaft, it must not be overlooked that the mass of the centre portion between these two joints is subject to cyclic variations, and this is one important factor which may limit the working angle.

In a few years' time the universal joint as we have known it in the past will probably be used more on medium range commercial vehicles than on passenger cars. Constant-velocity joints will become increasingly popular, particularly those designs which have only rolling friction, as opposed to sliding, or a combination of rolling and sliding. For small cars the drive will be concentrated at one end (frequently the front), and use a combination of constant velocity and torsionally flexible joints. On the slightly larger cheap production car the conventional Hotchkiss drive may well be with us for four or five years, but will be superseded by independent rear suspension, while for the large cars, front engine and rear drive is likely to be combined with independent rear suspension. On the more advanced models this will include grouping the transmission components together to form a single unit at the rear. Probably least change will take place on small trucks, while for the larger commercial vehicles with more complicated drives, the greater freedom provided by constant-velocity joints will be favoured.



Triumph Herald propeller shaft and suspension. Although used in this case on a car of under one litre capacity, a layout of this type is likely to find favour on larger cars in the future.



Mercedes-Benz single-pivot swing-axle final drive unit. The swing-axle rear suspension is popular on the Continent, particularly in Germany. The Daimler-Benz drive uses only one universal joint for the final drive shafts.

Noise is a Challenge that Must be Met

Experiments have long ago shown that noise can interfere with industrial output; it also interferes with health and happiness. These are excellent reasons for trying to reduce all forms of unnecessary noise.

THERE are probably two main factors that have retarded progress towards a quieter life in factories in the past; one is an unenlightened attitude of management and the other is the very real difficulty of treating noise and its effects quantitatively. Both of these are rapidly being overcome and the latest report of the Building Research Station, entitled "Noise in Factories," contains a considerable amount of quantitative information and practical advice on the subject.

HEALTH HAZARD

In dealing with the most dramatic effect that noise can have on personal health, the report points out that there is a wide variation between individuals in the noise levels that produce total loss of hearing. Further statistical experiments will therefore have to be carried out on a large scale before a critical noise level can be established. On the less dramatic side, both the degree and the frequency range of partial hearing loss must be further studied at great length before quantitative criteria can be established.

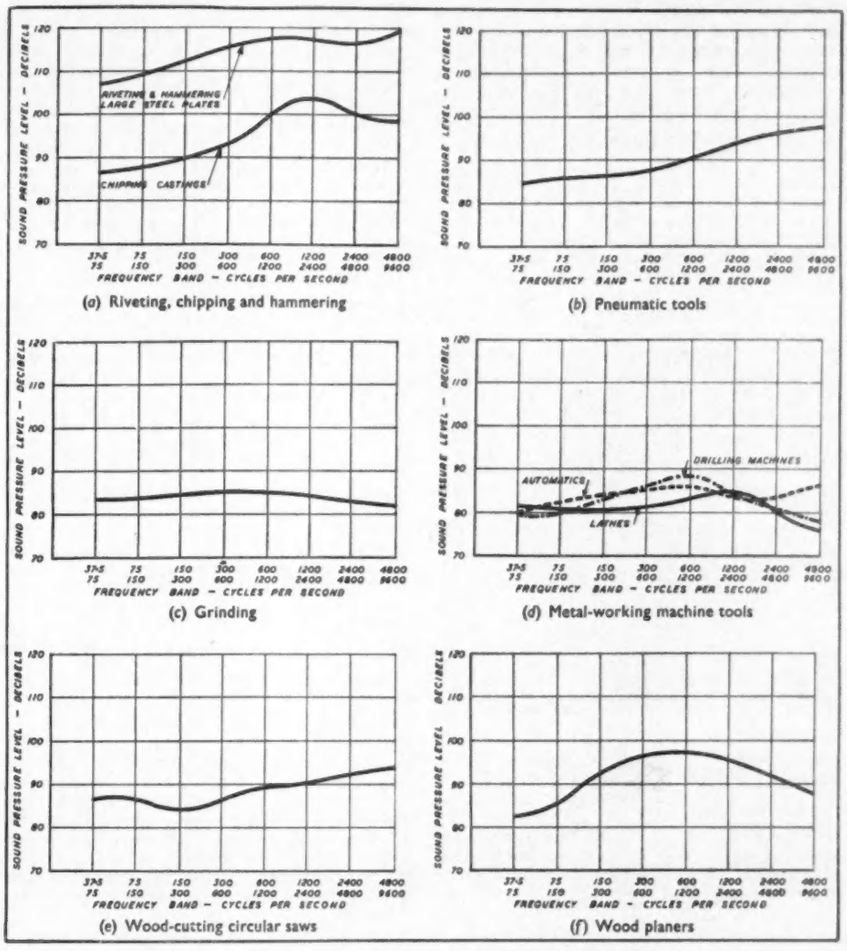
It has been found that the hearing of high frequency sound, especially around 4,000 cycles per second, is more sensitive to damage than hearing at other frequencies. Furthermore, noise has been found to cause its maximum damage to hearing at a frequency from half to one octave above its own frequency; so that noise at about 2,000 cycles per second will cause the greatest loss.

Although total loss of hearing is the most acute form of suffering that can arise from noise it does not occur very often. A much more general problem, one that can have a serious effect on factory efficiency, is interference with communication. In this context, the report points out that as the speech frequencies that contribute to intelligibility lie between 200 and 700 cycles per second, background noise in this range will tend to mask speech. To judge the interference effect of background noise, it is in most circumstances sufficient to use the arithmetical average of the noise levels in the three octave bands 600 to 1,200, 1,200 to 2,400, and 2,400 to 4,800 cycles per second to obtain the speech interference level. However, according to the report, if the noise level in the 300 to 600 band is more than 10 dB above that of the 600 to 1,200 band, then the average of *all four* bands (300 to 4,800 cycles per second) should be used. The table gives the conditions that just allow word intelligibility, for various background interference levels.

TABLE.—*Noise and Speech Interference*

SIL,* dB	Voice level and distance for word intelligibility	Nature of communication possible
45	Normal voice at 10ft	Relaxed conversation
55	Normal voice at 3 ft Raised voice at 6 ft Very loud voice at 12 ft	Continuous communication in work areas
65	Raised voice at 2 ft Very loud voice at 4 ft Shouting at 8 ft	Intermittent communication
75	Very loud voice at 1 ft Shouting at 2-3 ft ..	Minimal communication
85	Shouting at 1 ft ..	—

* Speech interference level



Typical noise spectra for some common industrial operations and machine tools.

The larger part of the report is, happily, devoted to practical means of reducing the noise level in factories. It is emphasised that noise should be reduced as near the source as possible. By this means the greatest number of people are protected and the effort involved is less extensive. It is obvious that if noise is to be reduced at source then it must be taken into consideration during the early stages of planning a factory, or factory extension. In this respect, not only can the layout be arranged favourably, but the choice of processes, all other things being equal, can be made to coincide with minimum noise. For example, welding, pressing and grinding would be better than riveting, forging and chipping (respectively), from the point of view of noise.

Although the choice of process must be governed mainly by the resulting production efficiency, the final noise level must also be taken into account. Apart from all other considerations, this can have an effect on staff recruitment, especially in areas where light and heavy engineering are in competition for a limited supply of labour.

The amount of noise radiated by a surface depends on the amplitude of the vibration and the area of the radiating surface. The amplitude will be governed by the resistance of the surface to movement and the power available to drive it. There are, then, two basic methods of reducing the noise at source—by reducing either the amount of energy communicated to the vibrating surface, or by reducing the efficiency of the surface as a radiator of noise. Unless the method of power application is changed, reducing the energy is only likely to be effective when the operation involved is not really essential to the process.

THE WORST OFFENDER

In general, noise from impacts appears to be the worst offender. Where impacts are essential to the process, as in hammering, riveting, etc., the possibilities of reducing noise at source are limited to using no more power than necessary, and preventing unnecessary impacts. If the impact can be spread over a short period, and thus converted into more of a shearing or squeezing action, an appreciable noise reduction is obtained. Riveting, punching and pressing are processes where this is sometimes possible. Impact not essential to the process can very often be quietened. For example, noise caused by the dropping of materials on hard surfaces can be reduced by simply covering surfaces with resilient materials.

After a fairly lengthy and most useful dissertation on methods of reducing other types of noise at source, and on means of reducing noise by factory layout, the 26 page report concludes with a short chapter on ear protection devices. This very simple means of preventing damage from noise is obviously not the conclusive answer to the problem, but it must not be overlooked as an expedient measure.

Ducted Fans Show Promise for VTOL

There have been some recent advances in gas turbine technology that have lead to the design of engines with high thrust-to-weight ratios. These may make vertical take-off by jet lift a practical possibility.

SEVERAL experimental jet lift aircraft for vertical take-off and landing have been built. But they have all shown, as was expected, that it is a long step from the bare achievement of jet lift to the production of an aircraft suitable for civil or military use. The outstanding problems involved are: control, the transition from vertical to horizontal flight and, of course, the power plant itself.

The thrust required for vertical take-off equals all the weight of the aircraft plus a safety margin of about 20 per cent. This may be ten times the thrust required by the same aircraft in normal cruising flight. The central problem, therefore, of the VTOL aircraft is that the total installed thrust is abnormally high but that, except for very high performance aircraft, most of it is only required for take-off and landing.

One way to achieve vertical take-off is to use a battery of specialised lifting engines together with independent propulsion engines. However, since the latter provides no lift, the total installed thrust becomes even greater than is necessary for take-off; from about 10 per cent greater in the case of a transport aircraft having the optimum subsonic lift/drag ratio, to nearly 100 per cent greater for a fighter.

To reduce the total installed thrust by enabling the propulsion engines to contribute to take-off it has been proposed that they should be arranged to drive lifting fans, either by shafts and gearing or by exhaust gas turbines. When sufficient height had been gained power could be withdrawn from the fans and the propulsion engines would resume their normal function.

DUAL PURPOSE ENGINE

The latest and apparently the simplest vertical take-off system so far, is one that has been announced by Bristol Siddeley Engines Limited. It comprises a dual purpose lift/thrust engine in which the whole thrust is delivered through movable nozzles which are turned downward for vertical take-off and progressively rearwards for forward flight. They can be turned forward for braking in flight and, of course, downward again for landing.

The fact that the nozzles can be turned progressively from downward to backward allows for a smooth transition from vertical take-off to forward flight. Moreover, in accordance with the parallelogram of forces, thrust which can be exerted in any required direction between vertical and horizontal is more effective than a combination of vertical and horizontal components. For example, if the nozzles are directed 30° backwards the vertical component will be 86 per cent of the total and the horizontal component 50 per cent. To achieve the same result with separate lifting and propulsion engines would require 36 per cent more thrust.

This directional flexibility also permits any type of take-off and landing from the vertical to the conventional (full length run), so that wherever possible a less steep take-off could be used to increase the payload.

Another advantage of movable nozzles is that they can be directed backward for taxying. This prevents unnecessary airfield erosion and the troubles that can arise from dust, debris, and the recirculation of exhaust gas. Even when a vertical take-off is to be made, the nozzles can be faced backward when the engines are opened up and then turned down for the actual take-off. In practice it would nearly always be possible to allow the aircraft to roll a few yards forward before turning the nozzles downwards. This would ensure that all dust and debris would be left behind so that the pilot would have clear visibility.

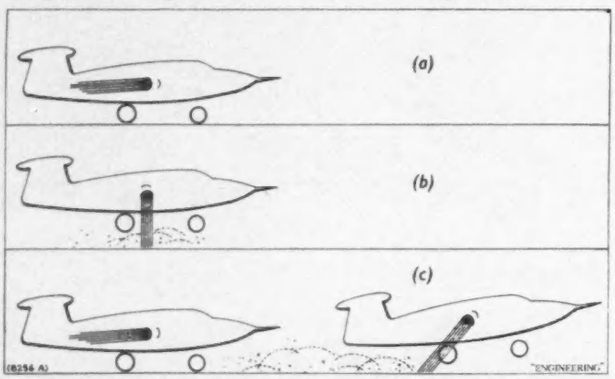
For simplicity and economy a single engine installation has much to recommend it for the lighter types of fighter and ground attack aircraft; as is now the standard practice for small high performance aircraft of conventional type. The lift/thrust engine is the only possible power plant for a single engine VTOL aircraft (apart from tail-sitters), but it is also perfectly suitable for a multi-engine installation. In either case only one type of engine is installed so that maintenance and spares provisioning are no more complicated than for conventional aircraft.

THE DUCTED FAN

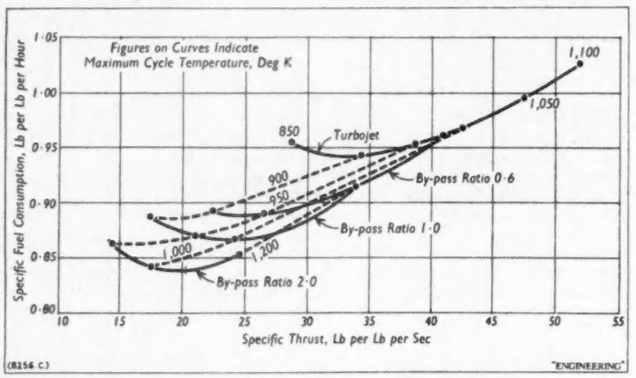
The nozzles of a typical Bristol Siddeley lift/thrust engine are so disposed that the centre of thrust coincides with the centre of gravity. This permits a conventional installation and the engine employs a normal forward facing air intake. Since any VTOL aircraft will require more thrust at take-off than at any other time, the Bristol Siddeley engines are of the high by-pass ratio ducted fan type. In addition to high thrust at take-off these engines promise other advantages.

The ducted fan is fundamentally a turbojet to which a fan has been added to enable it to entrain more air and project it at a lower jet velocity, so combining the advantages of the pure jet and the turboprop. Of the air entrained by the ducted fan some goes through the combustion system and is heated while the rest simply flows through the fan duct to the rear of the engine, remaining relatively cool.

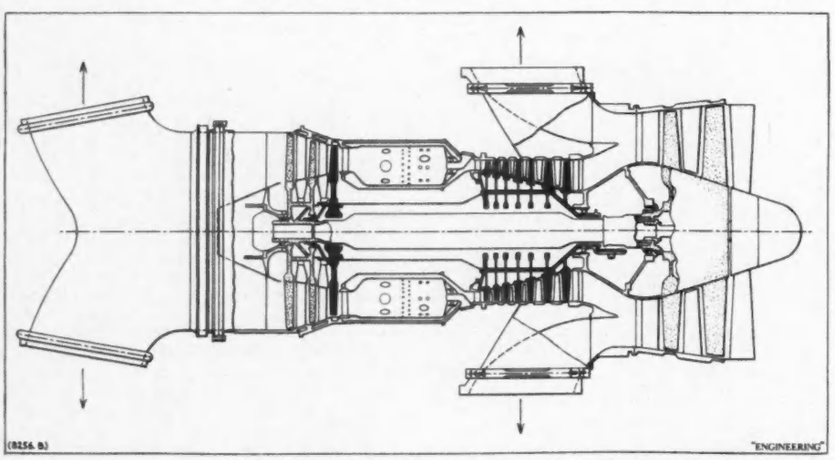
The ratio of duct air to combustion air (flow ratio) is important because it determines the characteristics of the engine. Ducted fans with a flow ratio of less than 1 to 1, that is, those in which a greater part of the air goes through the basic jet engine, are often referred to as by-pass engines. It can be argued that such engines have not so far shown any decisive advantage over the pure jet; but with flow ratios greater than 1 to 1 there is a more decisive improvement,



(a) Jet nozzles directed rearward for taxying, conventional take-off and forward flight. (b) Nozzles directed downward for vertical take-off. (c) Nozzles turned down for take-off after a short forward roll to clear dust.



This graph was used by P. Lloyd, of the National Gas Turbine Establishment, to show how the specific fuel consumption of a ducted fan engine is reduced by the adoption of a high cold-flow (by-pass) ratio.



A Bristol Siddeley fighter aircraft engine. The jet is directed down for vertical lift or at any inclined angle to give a combination of lift and thrust.

until a ratio of about 2 to 1 is reached. At this point the increasing size and weight of the engine threatens to offset the advantages of increased mass flow.

The Bristol Siddeley engines are designed to make the best of this situation, having flow ratios between 1·5 to 1 and 2 to 1. As a result they have four advantages over current turbojet engines of the same cruise thrust; advantages that may be of value on conventional aircraft as well as being most important to the VTOL type. They are said to offer 10 per cent improvement in specific fuel consumption, a 25 per cent improvement in take-off thrust, a 50 per cent decrease in noise (under normal take-off conditions). The engines are actually lighter than exsiting jet engines operating in the same thrust class.

The specific fuel consumption of such engines cruising at 36,000 ft and mach 0·8 is about 0·9 lb per lb per hour as compared with 1·06 lb per lb per hour for a typical by-pass engine of the same pressure ratio, and a slightly higher figure for a pure jet. During take-off and climb the ducted fan shows to even greater advantage. The specific fuel consumption of the same engine under sea-level static conditions is 0·572 lb per lb per hour. Under the same conditions many current turbojet engines have a specific fuel consumption greater than 1·1 lb per lb per hour.

The improvement in specific fuel consumption is slightly offset by an increased nacelle drag due to the greater diameter of the ducted fan as compared with the turbojet, but calculations show that for the type of engine under consideration this reduces the gain from 12·5 per cent to about 10 per cent, which is still a very substantial economy.

The take-off thrust of a ducted fan is much higher in relation to its cruising thrust than that of the turbojet, making it a likely proposition for VTOL aircraft. In the case of conventional take-off aircraft, if the engines are selected on the basis of their cruising thrust, then aircraft with ducted fans will have a much better take-off performance than those using pure jets. They will in fact approach the turboprops in this respect and be able to use the same short runways.

First Fully Automatic Beryllium Monitor

Beryllium is finding increasing use in industry but, since it is a highly toxic substance, it must, be handled with great care. One of the greatest dangers arises from the pollution of air with small particles of beryllium, which may be breathed in by personnel working in the vicinity.

In order to keep this hazard under control, the United Kingdom Atomic Energy Authority have developed a beryllium sampling monitor which is said to be the most accurate of its type in the world. Unlike previous methods of air analysis, this new device operates completely automatically, giving a reading of the beryllium level every 60 seconds. It will also sound an alarm if the toxic threshold level is reached.

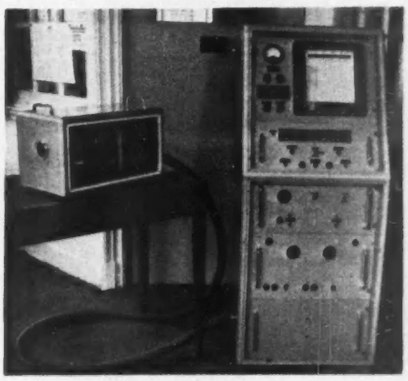
The toxic threshold for beryllium is one seventy-fifth that of lead and one-fiftieth of the next most toxic dusts, mercury and selenium. For any given eight hour period of contact, the recommended maximum beryllium level is 2 micrograms per cu. metre. It is also recommended that at no time should the instantaneous level rise above 25 micrograms per cu. metre. The results produced by the monitor are quantitative over the range 1 to 75 micrograms per cu. metre and they are not affected by the chemical form or size of particle in the atmosphere.

The air to be sampled is drawn through a specially designed chamber in which the beryllium present is optically excited as it passes through a triggered alternating arc. The chamber has been carefully designed aerodynamically to eliminate pockets of beryllium concentration. The triggered a.c. arc has a long time constant and a wide plasma cross-section which results in an efficient excitation of beryllium or its intermediates.

The ultra violet radiations from the excited beryllium are then resolved into their components by means of a spectrograph, which has been designed to have a high dispersive power. The intensity of the beryllium doubles at 3,130Å, which is proportional to the beryllium concentration in the air sample, is measured photoelectrically and then the ratio of intensity of this double to the intensity of the adjacent background is recorded on a chart.

The arc chamber is designed so that the air sample is directed into the centre of the arc and the electrodes are placed so that the air flow is along the length of the arc plasma, ensuring that airborne dust remains in the excitation zone for the maximum time.

The calibration of the monitor, which is done automatically every half hour, is achieved by the use of a condensed spark discharge between a beryllium-copper electrode and a copper counter electrode, producing an aerosol with a uniform concentration of beryllium at a uniform rate. The air for this is drawn in through a filter to eliminate any beryllium particles from the outside air.



The monitor is fully automatic and operates on a predetermined cycle, in which it is calibrated regularly and records the beryllium level at one minute intervals.

Systematic Tests Prove Rain Seeding

A report of large-scale investigations into the physics of cloud formation and rain is given in the latest annual report of the Commonwealth Scientific and Industrial Research Organisation, published by the Government of Australia.

The initial object, which was to obtain a sound assessment of the potentialities of rain seeding, are reported to have been largely realised. Continuing from this, experiments are now well under way to establish the practicability of increasing the rain precipitation of several large areas of Australia.

Rain occurs naturally by one of two physical processes: by ice crystal formation in supercooled clouds, or by the coagulation or coalescence of water droplets in clouds above freezing point. Minute dust-like particles ("nuclei") in the atmosphere play a vital part in initiating both types of rain. By supplying substitutes when naturally effective nuclei are absent or ineffective, rain can be induced artificially. Current work on rainmaking has been devoted mainly to large-scale seeding, using crystals of silver iodide, the most effective artificial freezing nuclei yet discovered. Studies are also being made of the nature and occurrence of the natural freezing nuclei responsible for initiating the rain formation process in supercooled clouds.

Cumulus clouds contain much less water than would be expected from the simple adiabatic model of cloud growth, and a theory has been developed to account for this discrepancy. This suggests that dry air is engulfed at the tops of growing clouds so that cloud droplets evaporate, cooling the air and causing it to sink. These parcels of dry air may penetrate downwards to considerable distances. Equipment has been developed for mounting in aircraft to study the fine structure of cumuli, and the first flight programme has been completed. Observations were made at different levels in many clouds and the data collected are now being analysed.

A chemical diffusion method has been developed to measure those nuclei in the air which promote condensation at slight supersaturations, and which are important for cloud formation. It is believed that differences in the stability of clouds and their ability to precipitate may be caused primarily by differences in the nucleus content of the air in which they form.

Naturally occurring freezing nuclei are thought to be dust particles having the property of producing ice crystals in supercooled clouds of water droplets. Several measurements of their concentration have been made every day by the CSIRO for some time but, because isolated counts may not be truly representative of actual concentrations, a continuously operated automatic cold box has now been developed. This device samples air at a faster rate than is possible with manual equipment and, over a period of six months, has provided measurements for 70 per cent of the time. With this technique, short lived peaks in concentration (of the order of 8 hours duration) have been found to occur occasionally without any correlation with changes in wind speed or direction.

Studies of ice crystal nucleation have led to a theory for the activity of silver iodide as an ice crystal nucleus. Theories have also been developed for the size distribution of smoke particles produced by silver iodide burners, and for the de-activation of silver iodide particles by sunlight. This has made it possible to specify the output of an ideal burner, with which practical burners can now be compared for efficiency.

Properties have been studied of silver iodide dispersions produced by spraying a solution of silver iodide in liquid ammonia. This dispersion method may yield a greater number of nuclei, active at temperatures above $-10°$ C, than the burning of acetone solution has done in the past. This is expected to lead to a greater seeding rate and arrangements have now been made for practical flight tests.

In a large-scale experiment in the Snowy Mountains area, certain regions have been rain seeded under controlled conditions for several years. Analysis of the results has shown that the rainfall has been increased by 12 to 19 per cent.

Laminating with Glass

Using glass fibres to reinforce resin mouldings has become quite commonplace and articles made in this way are spread over most fields. There are car bodies, lifeboats, dinghies, caravans and kitchen sinks, drain pipes, gutters and bathing pools. Used alone, glass fibres are woven to form curtains and coverings.

The great advantage of the material is that it will resist corrosion and weathering. If damaged it can be patched in a very short time and it can be coloured right through so that wear of the surface will never cause any colour change, nor will it ever need painting. It is virtually fireproof and can be extremely resilient, otherwise it could not be used for the tips of fishing rods.

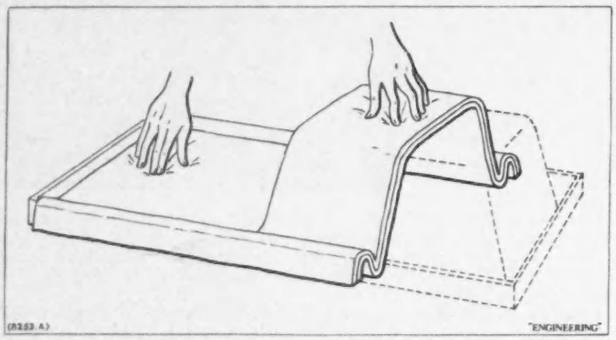
As a new material it has had to make its way in the world, but is by now generally accepted—for ready made items. The idea of using it as a home modelling material is more recent and does not seem to have spread very widely as yet.

A series of leaflets is available (some of them have been combined to form a comprehensive booklet) dealing with various aspects of the art. Included are boats, sinks, motorcar mudguards and caravan roofs, apart from suggestions for repairs to damaged glass fibre objects. Most constructional items start with a mould on which the laminate is laid.

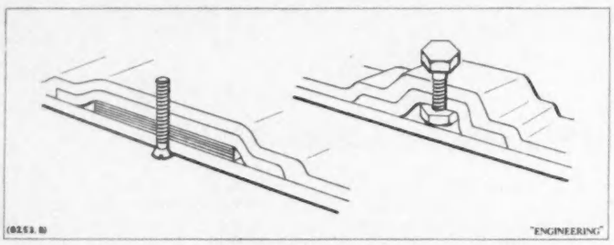
and therefore it is normally used as the first and the final layers of the reinforcement so that it comes on the outside of the work. Approximately 2½ oz of resin is needed for 9 sq. ft of tissue. It also is made in 36 in width. Last of the four is a woven ribbon 2 in wide and 0·007 in thick, which is normally used for reinforcing and binding edges.

To go with the fibre there are resins for different conditions. The standard cold cure material, requiring the addition of a hardener to set; a thixotropic paste for application on vertical surfaces and as a thickener for the general form; the hardener; a filler powder to give extra surface hardness and to economise in the amount of resin used; and a wax release agent for painting the mould surfaces to prevent the lamination from adhering.

It is claimed that the process of making up a laminate is a simple one not requiring any expert skill. It is slightly reminiscent of the papier maché technique of a past generation. Over the surface of the mould, which may be of any non-porous material or if porous treated with shellac or other sizing substance, is painted first the releasing agent and then a coat of resin mixed with thixotropic paste and hardener. Over this a coat of laminating resin is applied and then the glass mat on top. Other layers of



(Left) To make a sink unit, layers of fibre and resin are built up on a mould.



(Right) Reinforcements and bolt fixings can be incorporated where desired.

The glass fibre is being produced in four main forms to provide for most applications. A chopped strand mat made in 36 in widths consists of chopped glass strands approximately 2 in long, randomly distributed and bonded together. The use is for general reinforcement purposes and the mat weighs about 1 oz per sq. ft. The amount used will of course depend on the final strength requirements but as an example, a motor car body will need 2 oz per sq. ft—that is two layers of the mat. To obtain thorough impregnation the mat requires three times its own weight of resin.

Glass fibre scrim is a woven cloth weighing 5 oz per sq. yard and measuring 0·007 in thick. It is a higher cost material and is used for forming skins as on boats; used to sandwich a layer of chopped strand mat it gives a high strength laminate. Being rather more flexible than the mat it is widely used when making curved and intricate shapes. Scrim is made in 36 in width and in rolls up to 25 yards long. It needs its own weight of resin for full impregnation.

The third form available is tissue which is a thin sheet similar to a thick tissue paper. Its principal use is for obtaining a smooth surface resin and mat are then applied until the required thickness is obtained. A final rolling then removes all air bubbles and compresses the whole. Setting takes about 24 hours, after which the laminate may be prised away.

The cast can be trimmed with a hacksaw, knife or abrasive wheel, and the release agent cleaned off, especially if it is to be painted. All cut edges must then be sealed. Large flat surfaces require reinforcement which can be made by forming ribs over formers of wood or plastics tube. The formers can be left in place or removed as desired. Bolts can be set in the laminate to provide fixings for subsequent joining or erection. Butt joints and brackets can be made where needed.

For forming a skin on a boat or on a caravan roof, one or more layers of scrim can be laid directly on the wood surface. The resin will bond to the wood well, especially if the surface is slightly rough. Other uses include floor covering for vehicles subjected to hard wear or liable to corrosion by liquids.

Suppliers of the glass fibre and resin are Douglas Holt (Estd. 1919) Limited, Vulcan Way, New Addington, Surrey, who also produce the descriptive literature.

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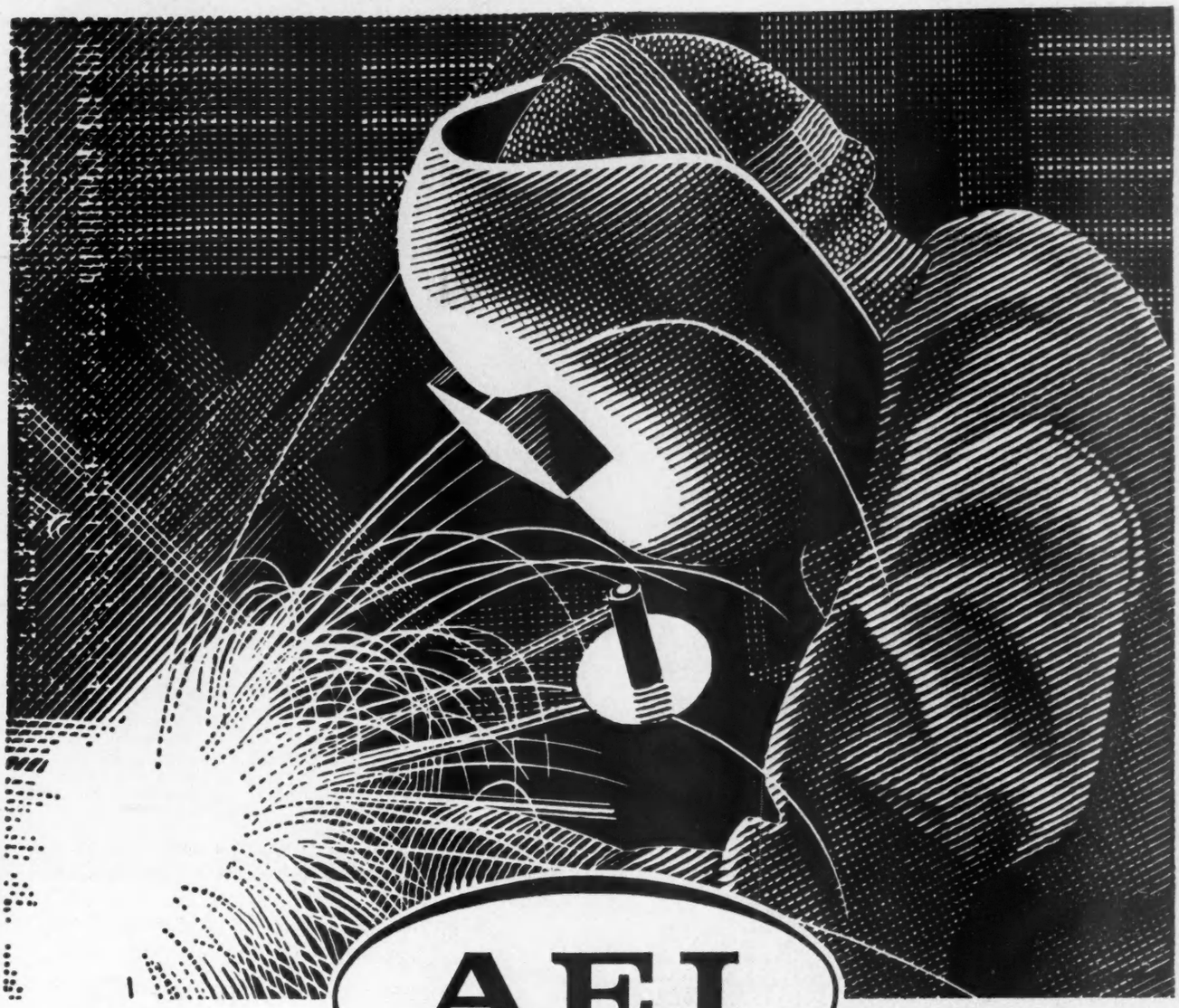

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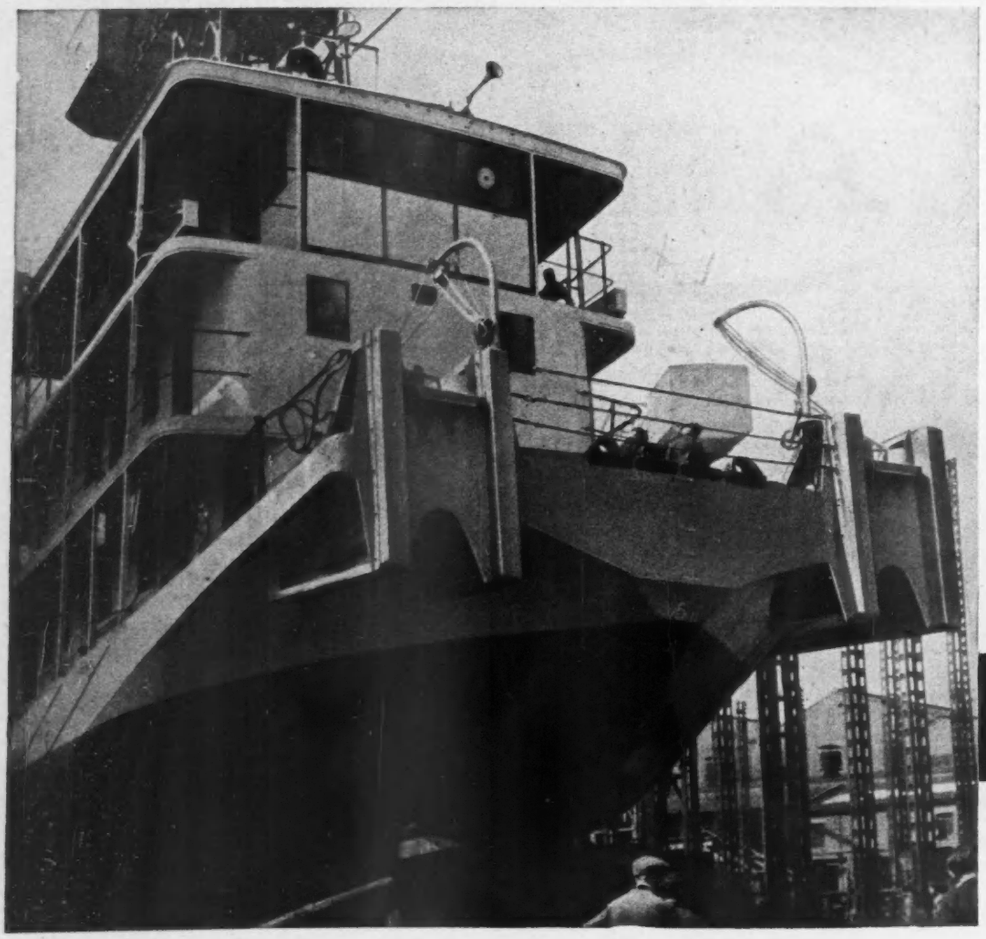

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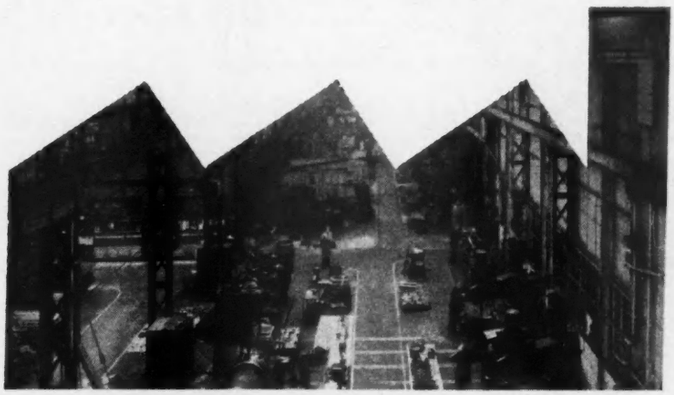

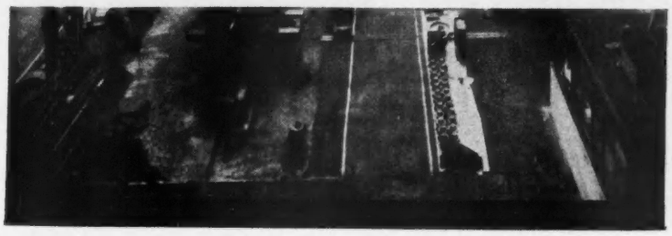

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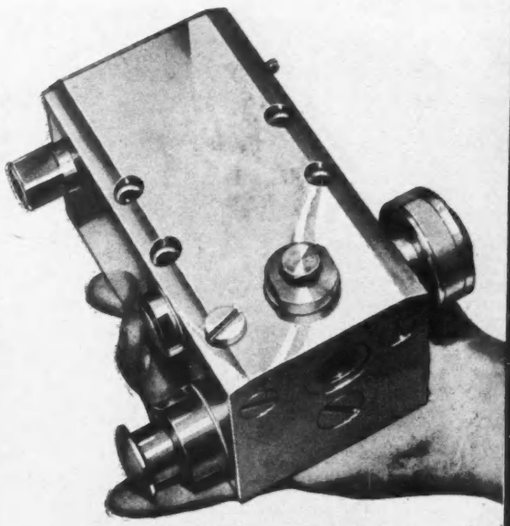

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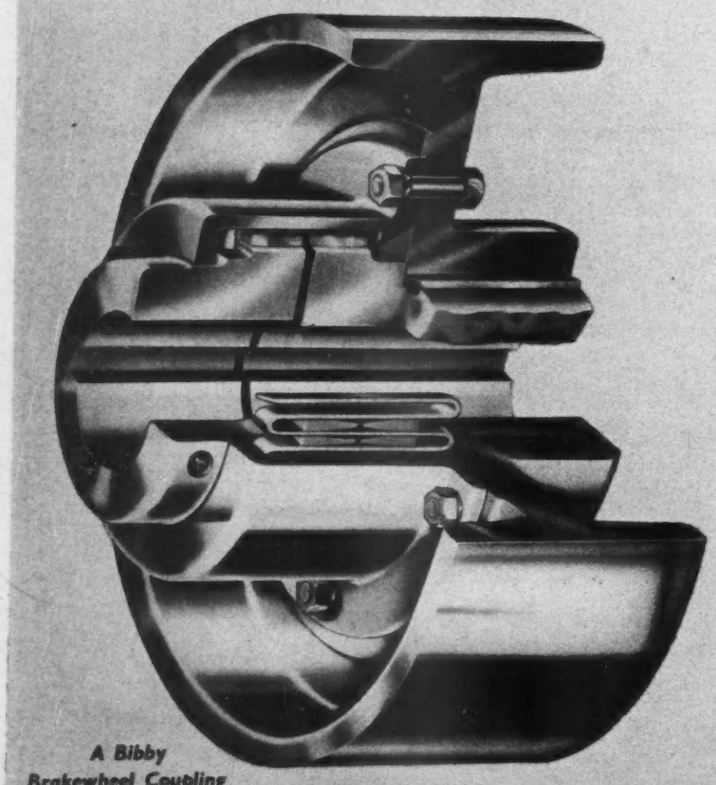

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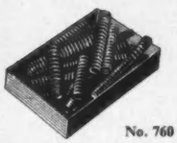

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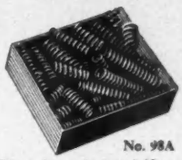

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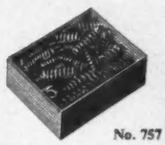

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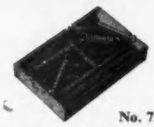

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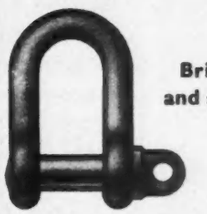

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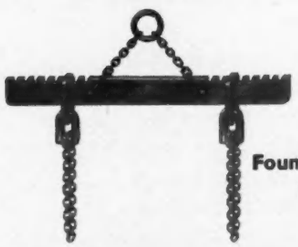

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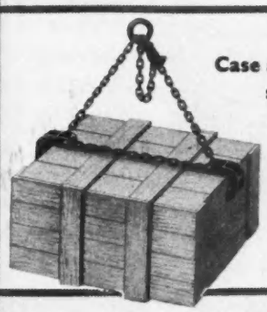

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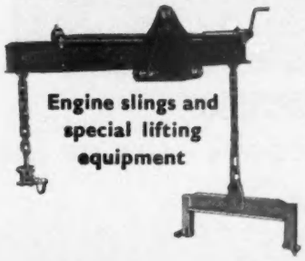

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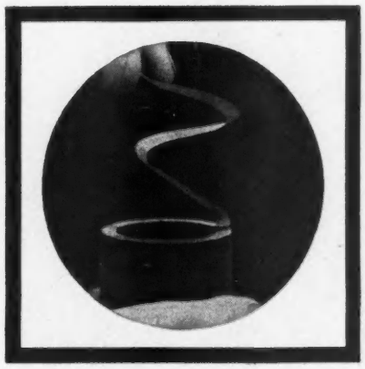

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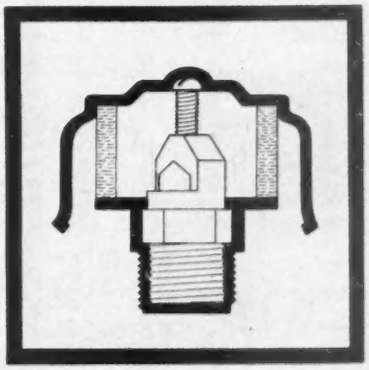

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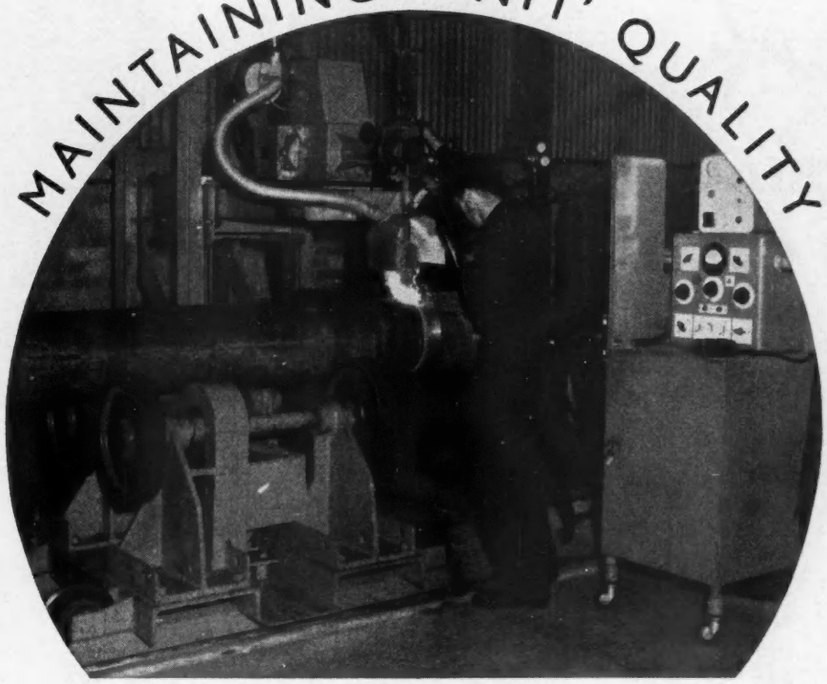

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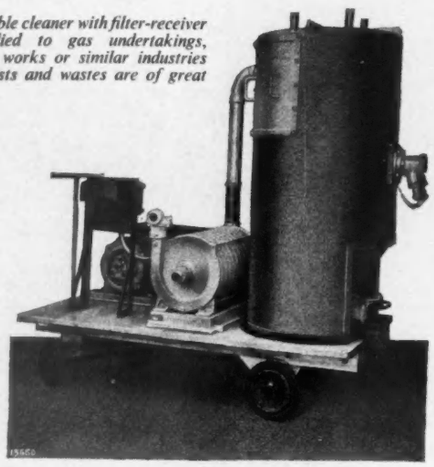
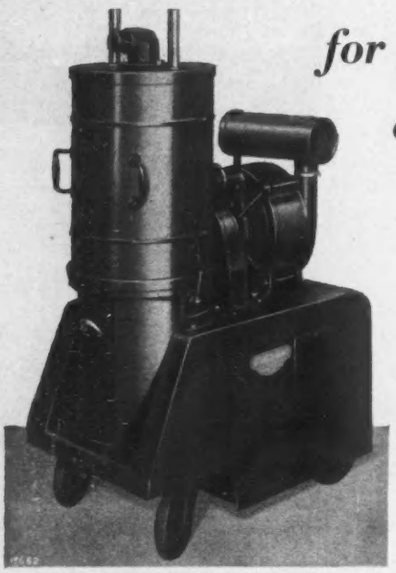
Sturtevant
INDUSTRIAL VACUUM CLEANERS



6X Portable cleaner with filter-receiver as supplied to gas undertakings, chemical works or similar industries where dusts and wastes are of great density.

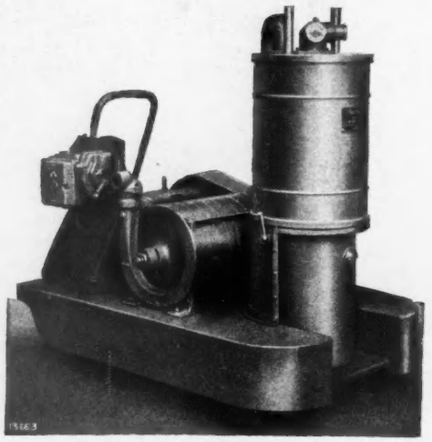
for heavy-duty cleaning in all industries



The 6X3, latest machine in the Sturtevant range, is specially designed for operation in congested areas.

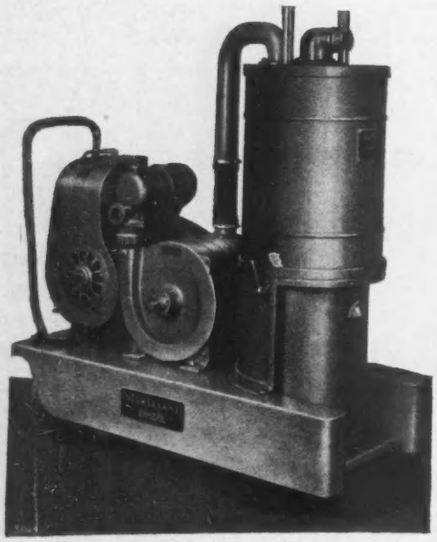
Sturtevant heavy-duty vacuum cleaners have *a wide and successful application in Industry*. In foundries, engineering, gas undertakings, power stations, chemical works, and factories of all kinds they thoroughly clean every surface, even where conditions are severe, dusts particularly heavy, and waste bulky.

The regular use of these powerful cleaners ensures dirt-free conditions, so essential to *continuous production, the preservation of machinery and fittings, and the health and well-being of workers.*



6X Portable cleaner mounted on a fabricated steel truck. Designed for heavy working conditions where there is complete freedom of movement.

Details of Sturtevant Industrial Vacuum Cleaners are given in publication D5014/5 which will be sent on request.



A Sturtevant 6X Portable cleaner, driven by a petrol engine.

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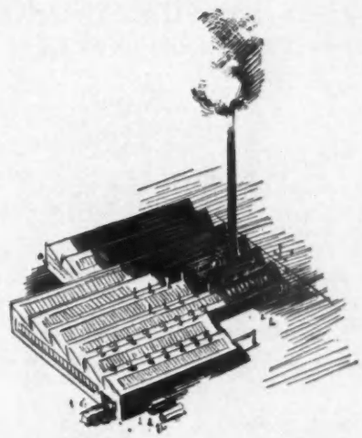

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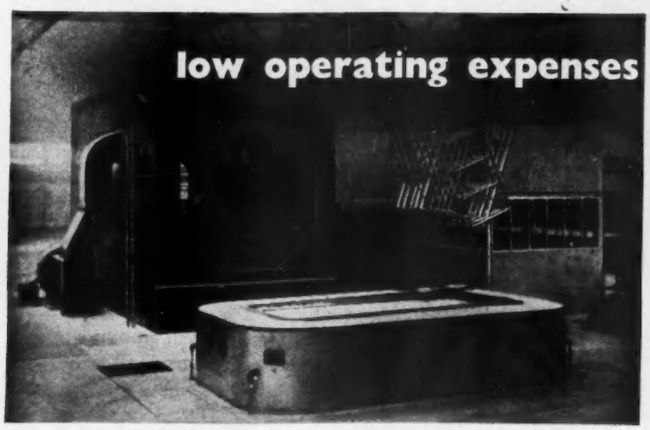

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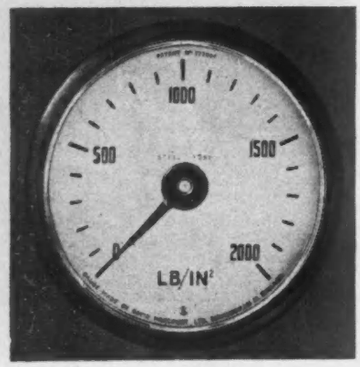

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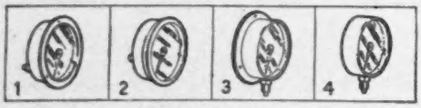
(3) Surface mounting, with bottom connection.
(4) Direct mounting, with bottom connection.



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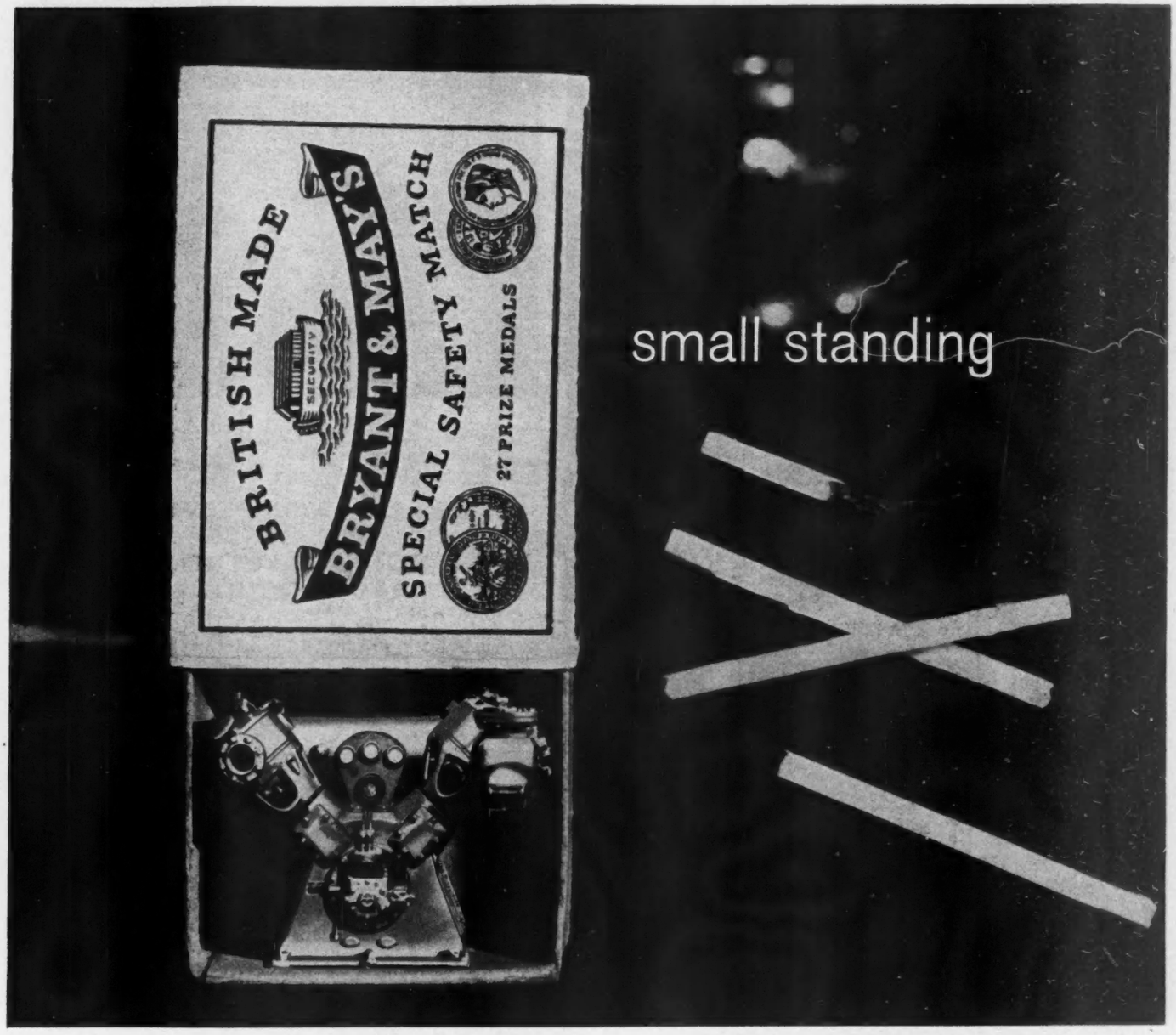

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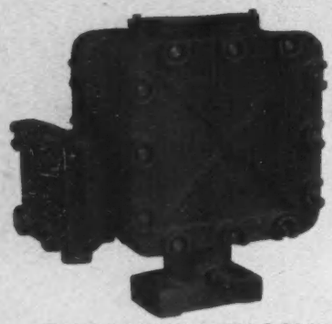

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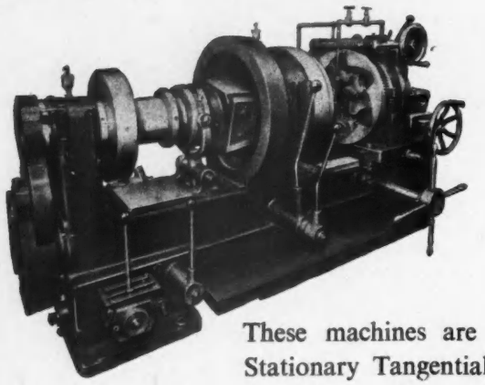

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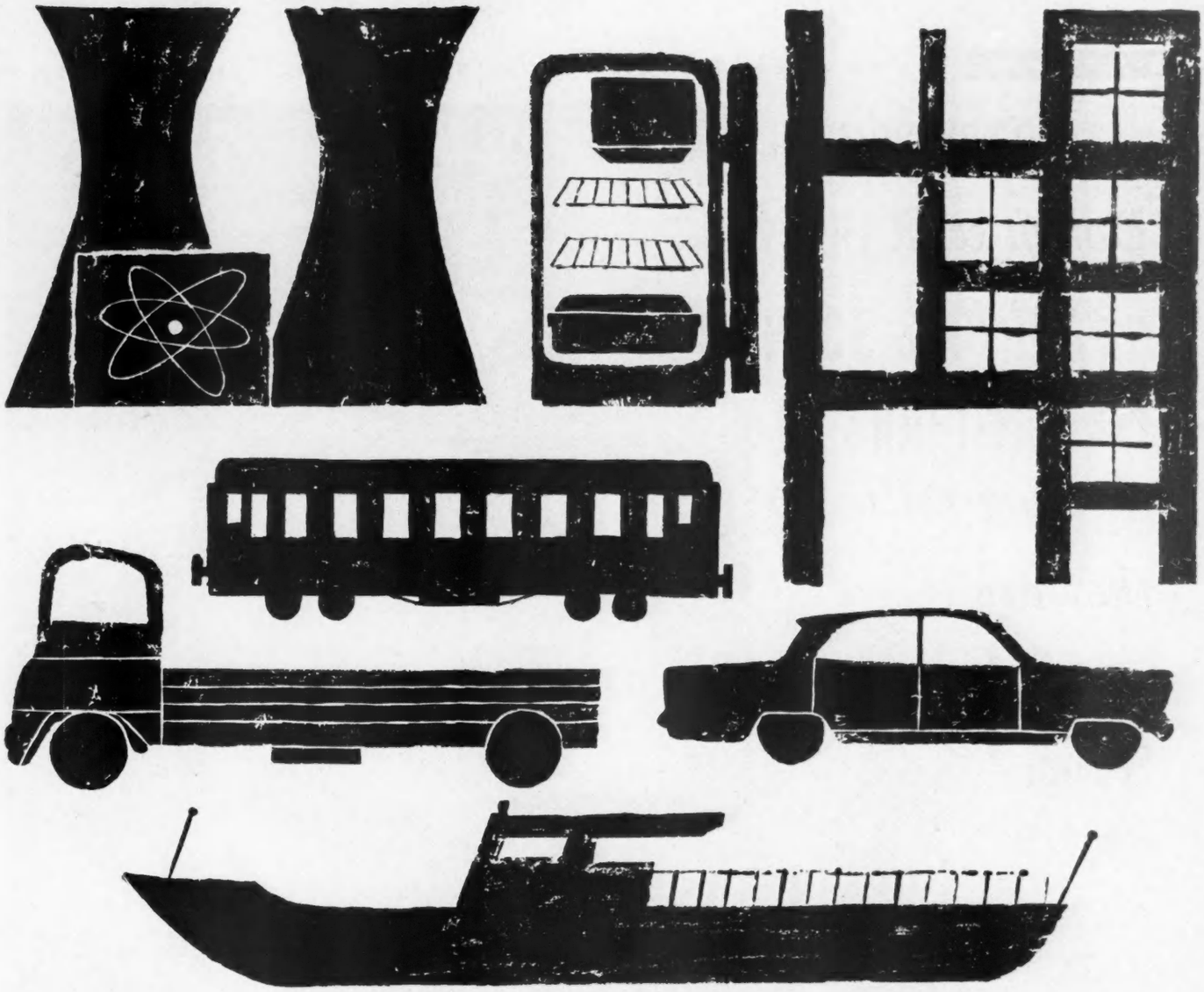

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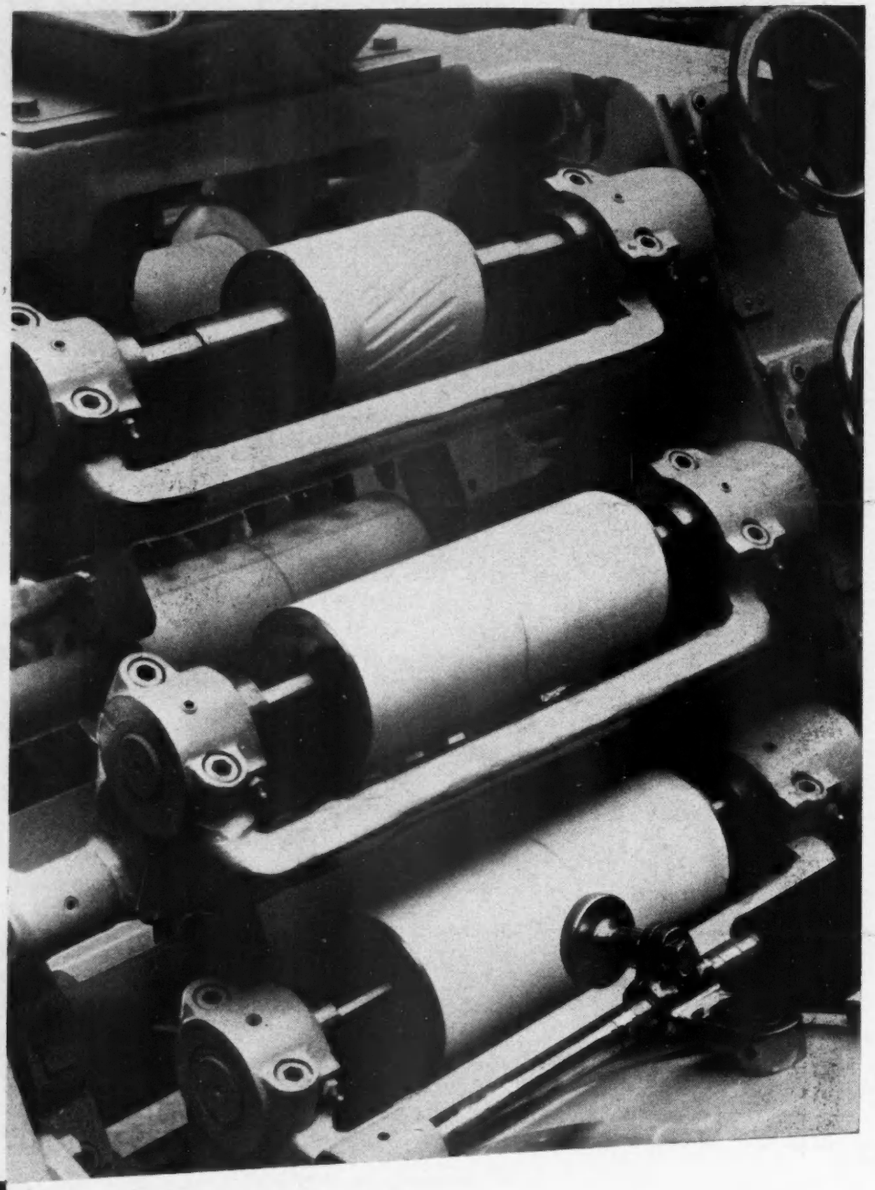
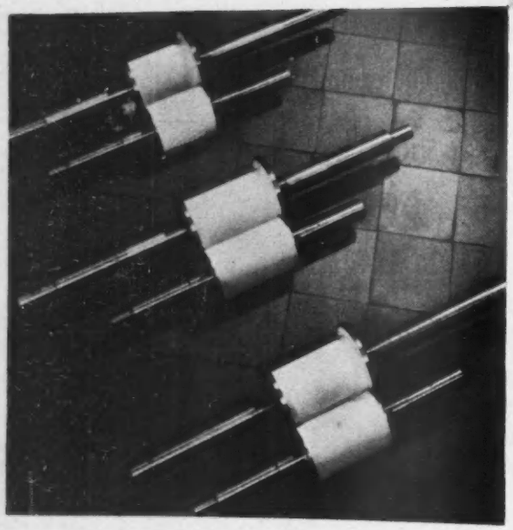
Dough will not stick to these sheeting rolls– they are covered with 'Fluon'



On the right: heavy duty drum moulder made by Baker Perkins Ltd., Peterborough, on which the sheeting rolls are covered by James Walker & Co. Ltd., Woking, with sleeves made from 'Fluon' p.t.f.e.

Below: three pairs of sheeting rolls for heavy duty drum moulder showing sleeves made from 'Fluon' p.t.f.e.



SHEETING rolls on a heavy duty drum moulder made by Baker Perkins Limited, Peterborough, are covered with sleeves made from 'Fluon' p.t.f.e. by James Walker & Co. Ltd. Because 'Fluon' is used, dough will not stick to the rolls. This means wastage of dough is reduced. It means, too, that the machine can run continuously because it does not need to be stopped for the rollers to be scraped clean.

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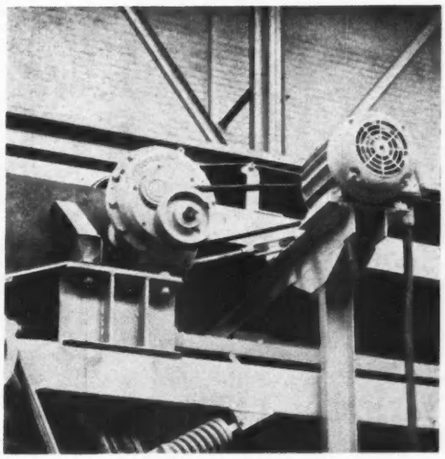

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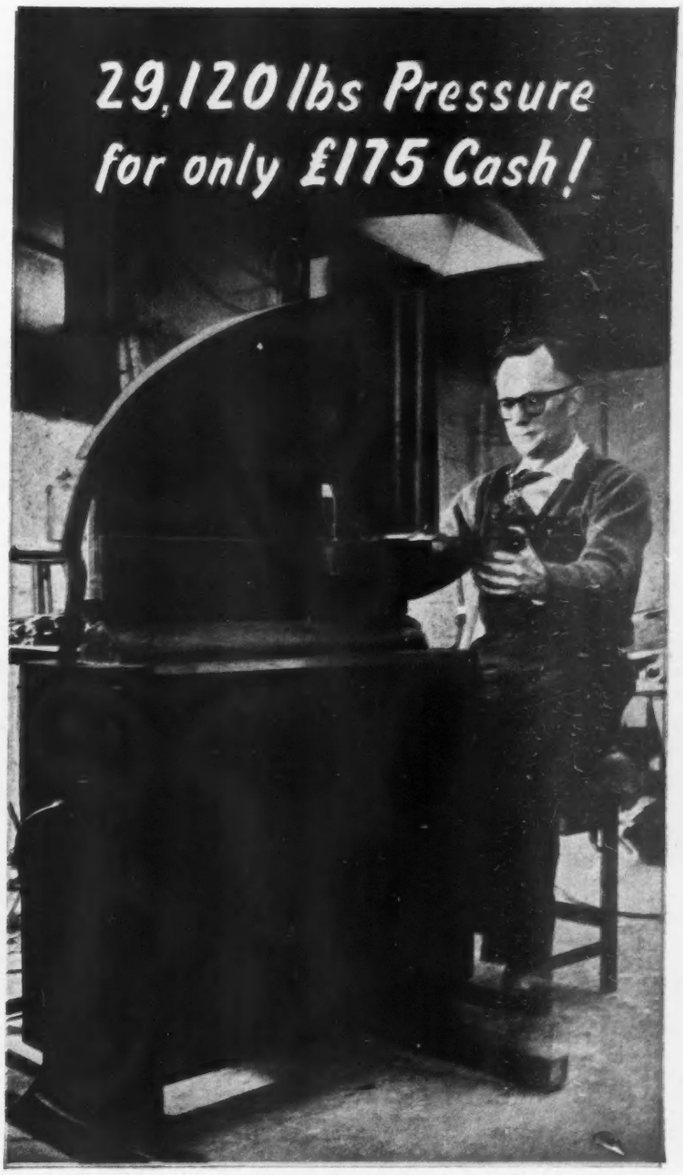

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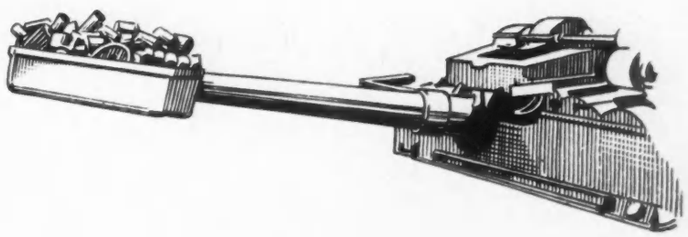

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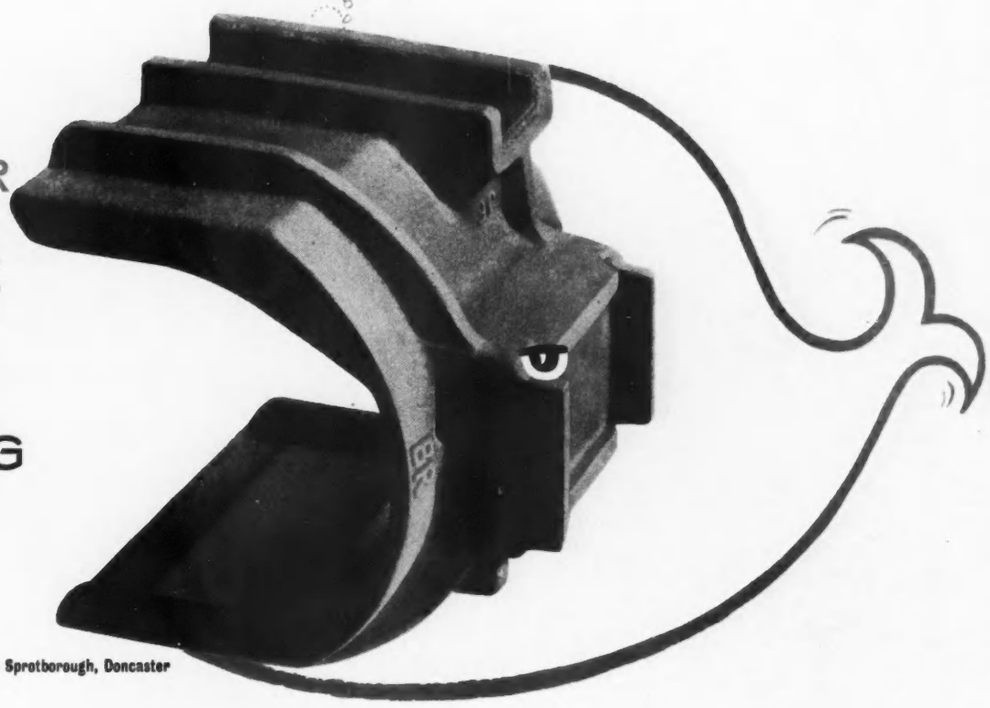

Technical brochure from
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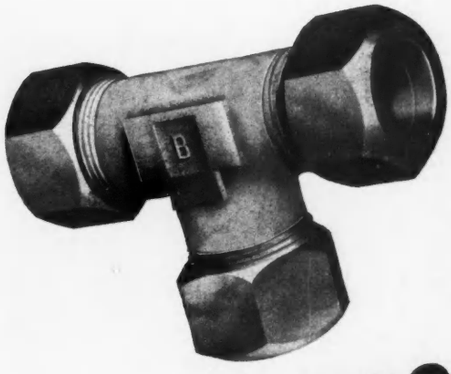

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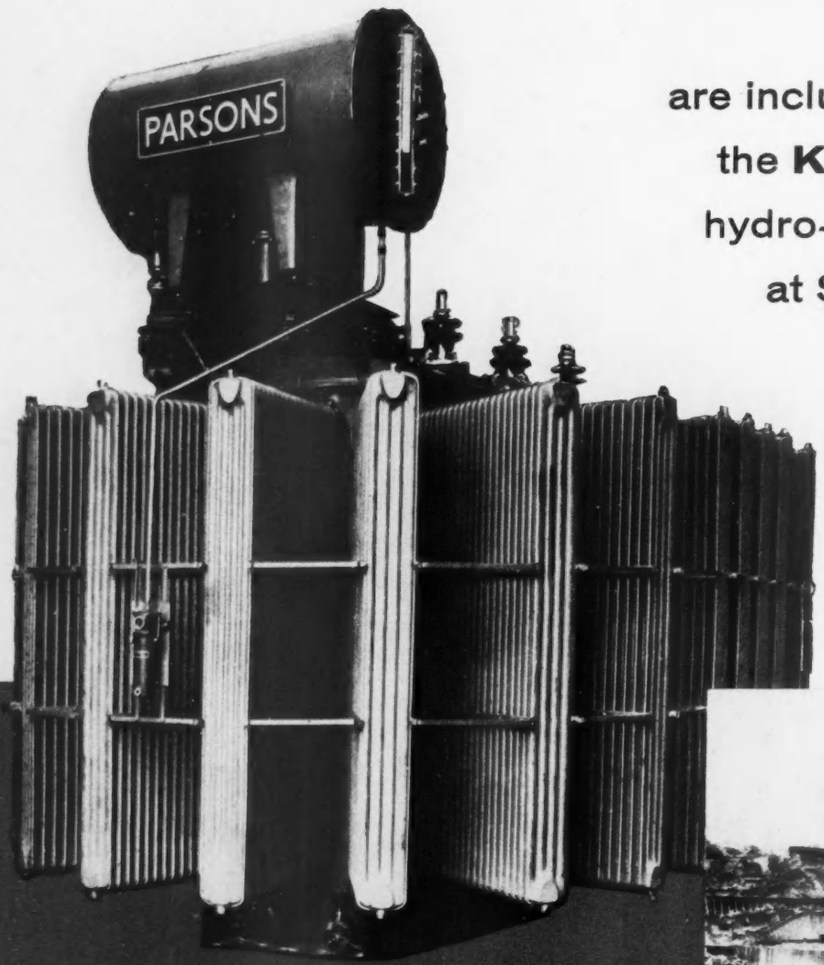

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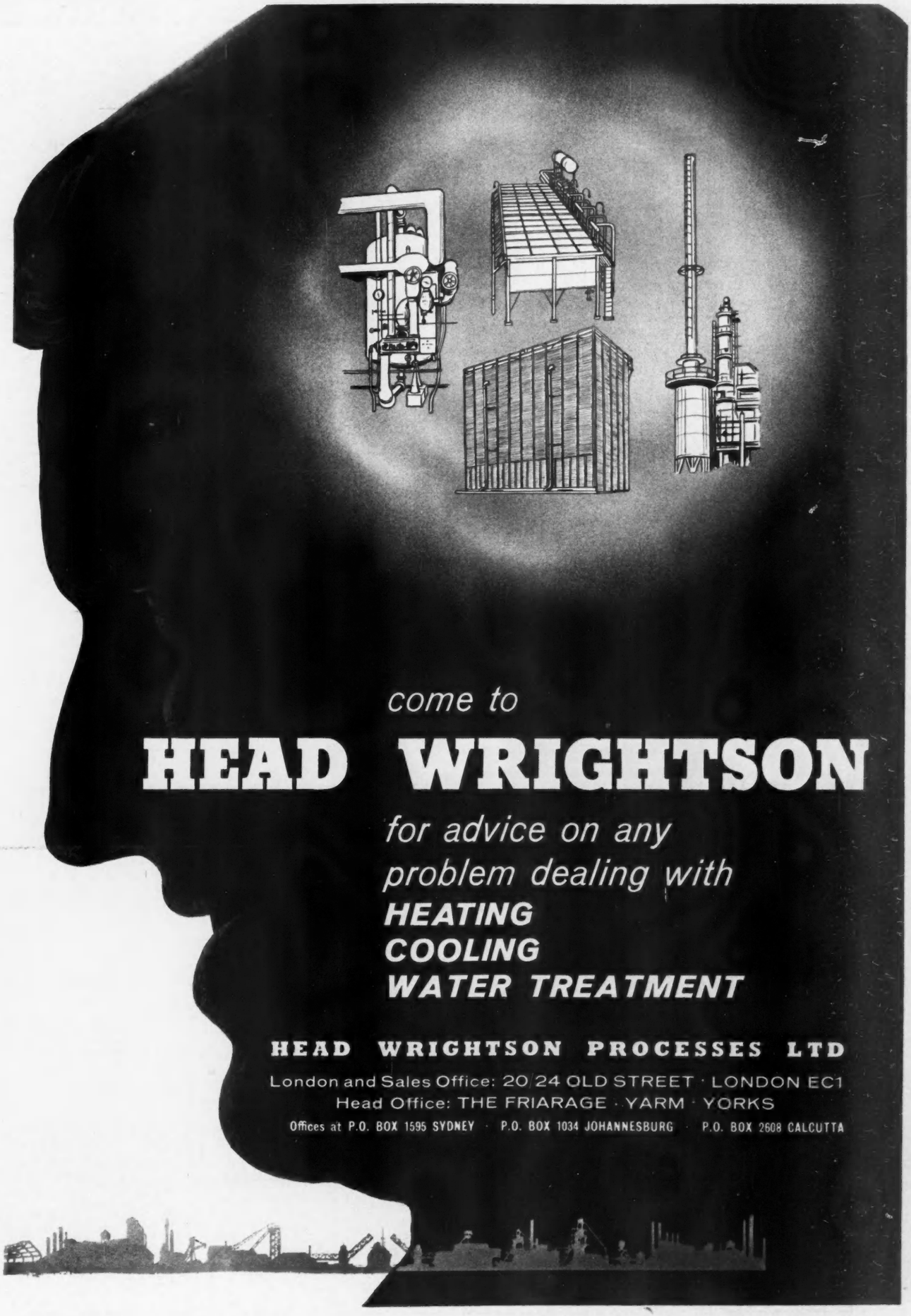
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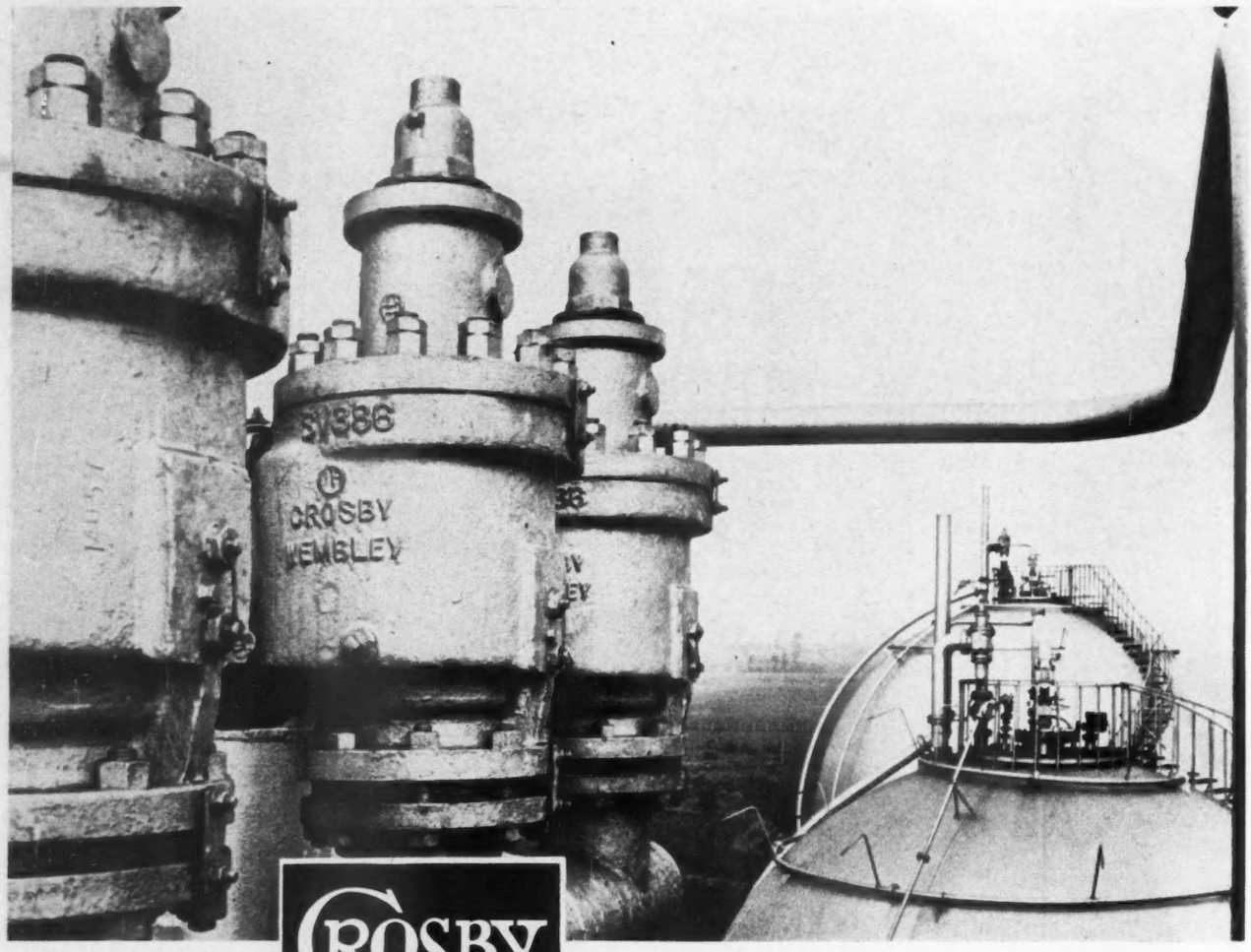

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Illustration shows three of four 6 x 8 Crosby Relief Valves together with Masoneilan Liquid Level Transmitters mounted on each of three Butane Storage Horton Spheres at Shell Haven. These relief valves protect the tanks from overpressuring due to fire, accidental overfilling or any other cause. The level instruments transmit the level of liquid Butane in the Spheres back to the Receiver in the control room. The reliability of this equipment is thus exemplified once again by one of the major oil companies of the world.

IMPORTANT ANNOUNCEMENT

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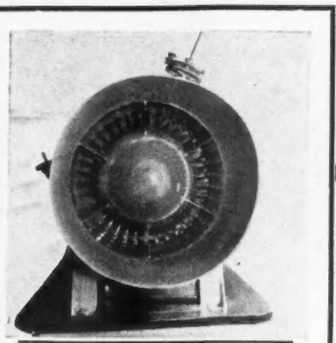
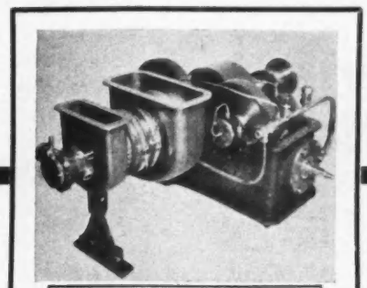
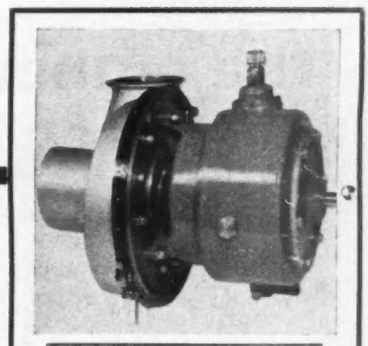


Axial Flow Air Compressor

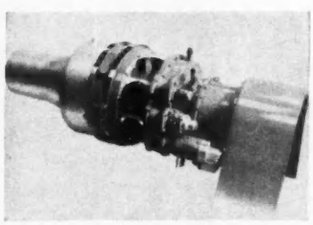


350 H.P. Turbine for Gasifier

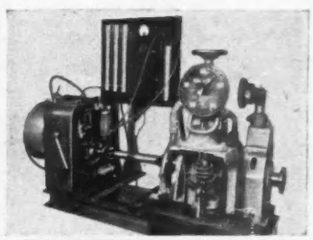


Radial Flow Free Power Turbine

GAS TURBINE DRIVEN MACHINERY



500 H.P. "Basilisk" Gas Turbine (Shaft Power and Air Bleed versions)



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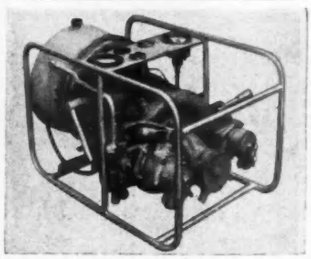
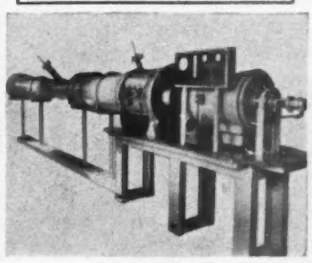


Axial Flow Compressor for Instructional Use



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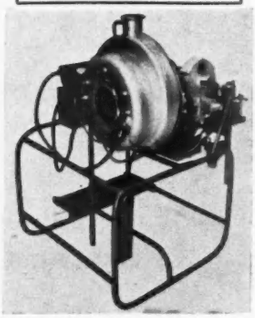

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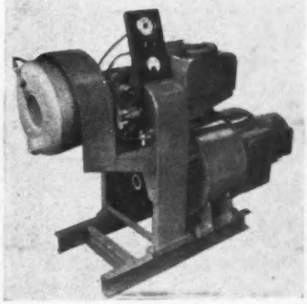

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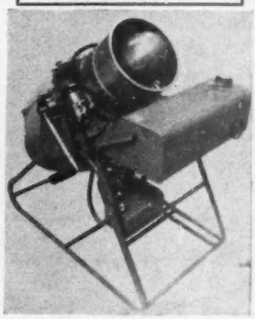

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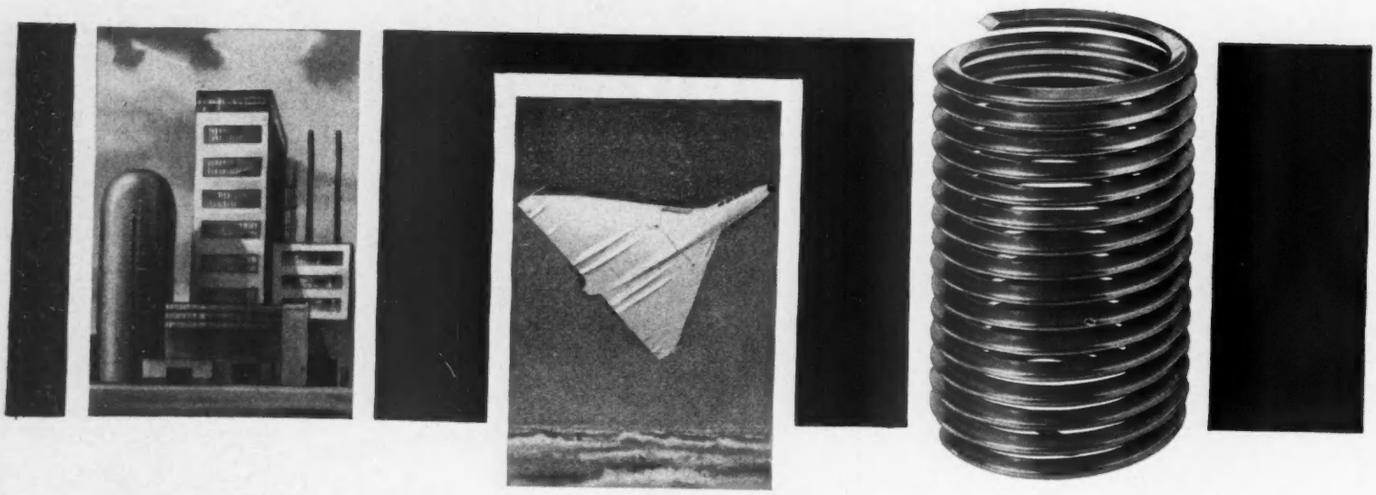

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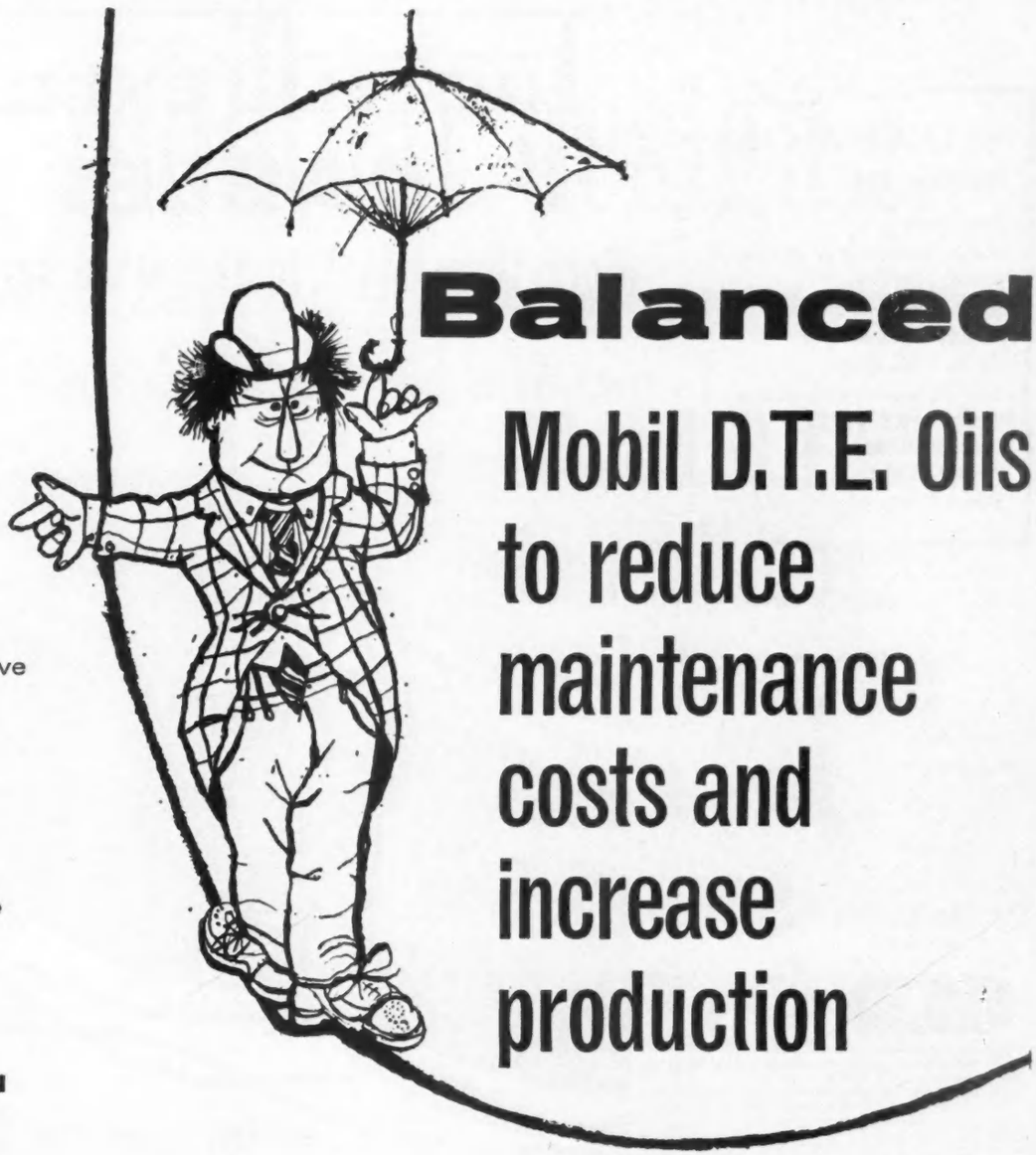

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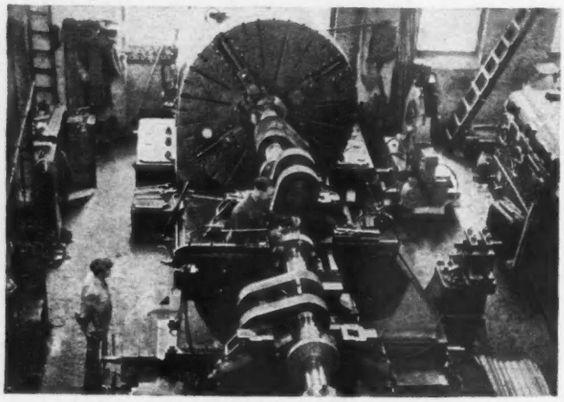

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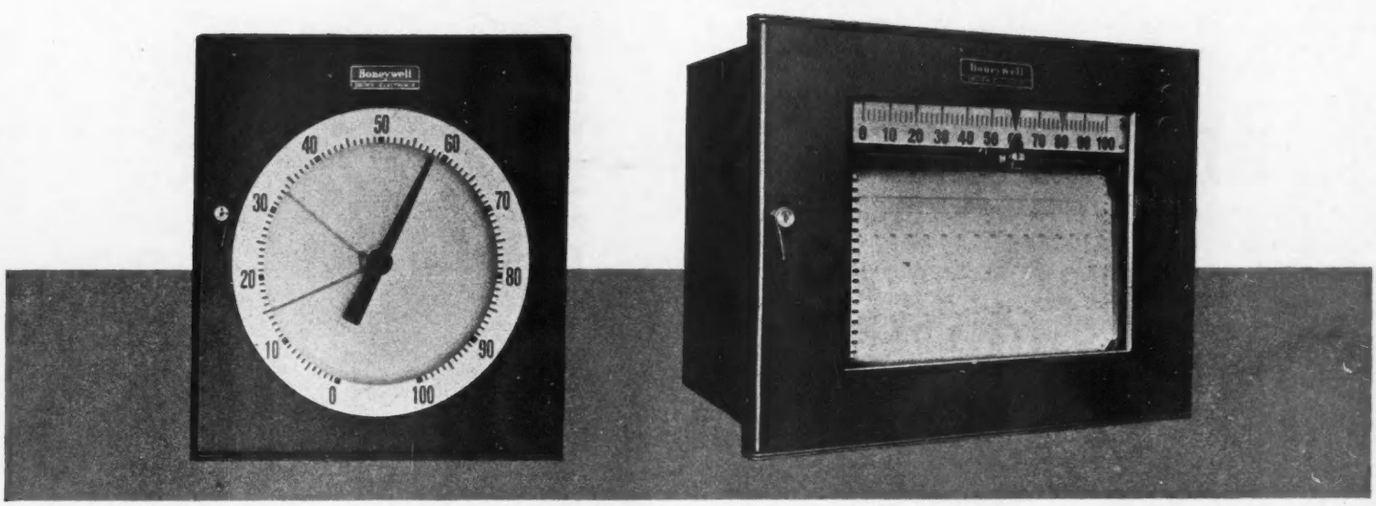

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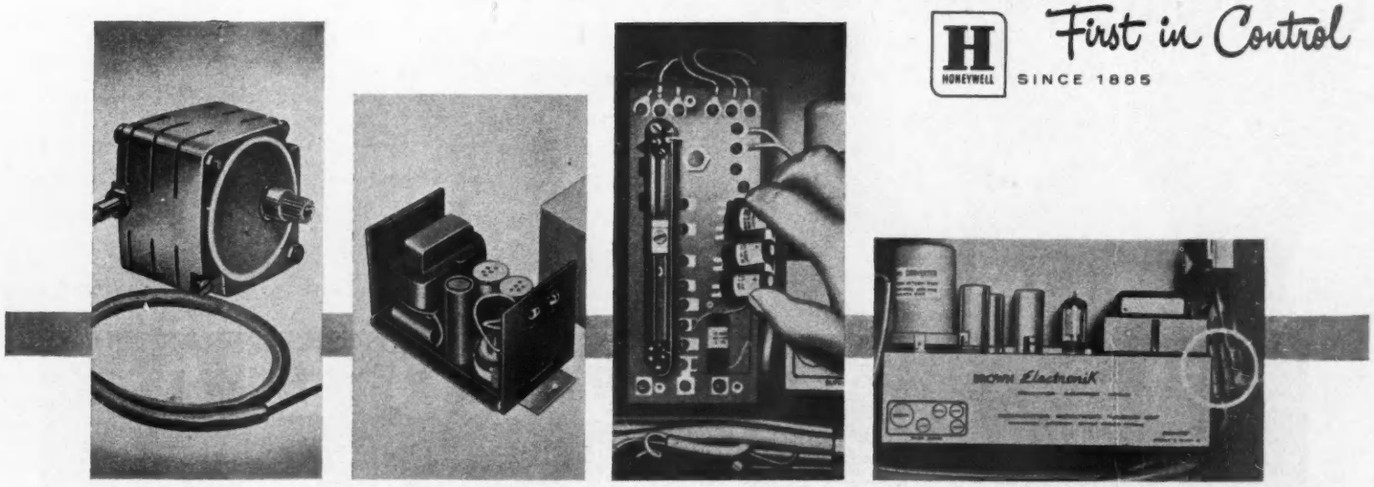

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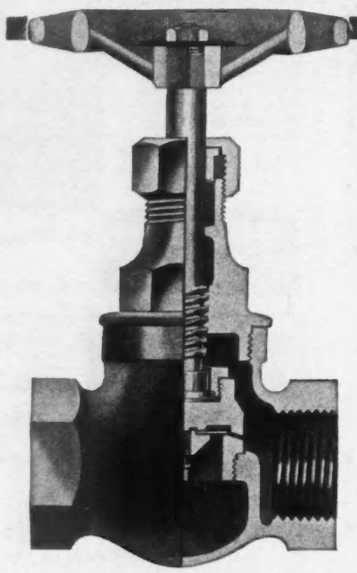

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* *The Flexible Titanium Disk is protected by Patent No. 822147*

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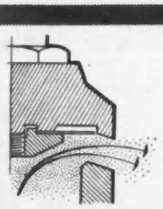
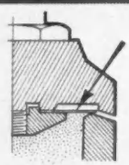
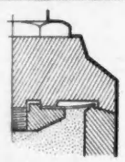


In open position free passage for flow directed across seating surfaces.



In 'Pre-shut' position flow and pipe scale held back by *Flexible Titanium Disk*. Patent No. 822147



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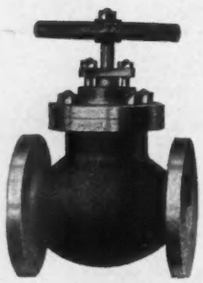

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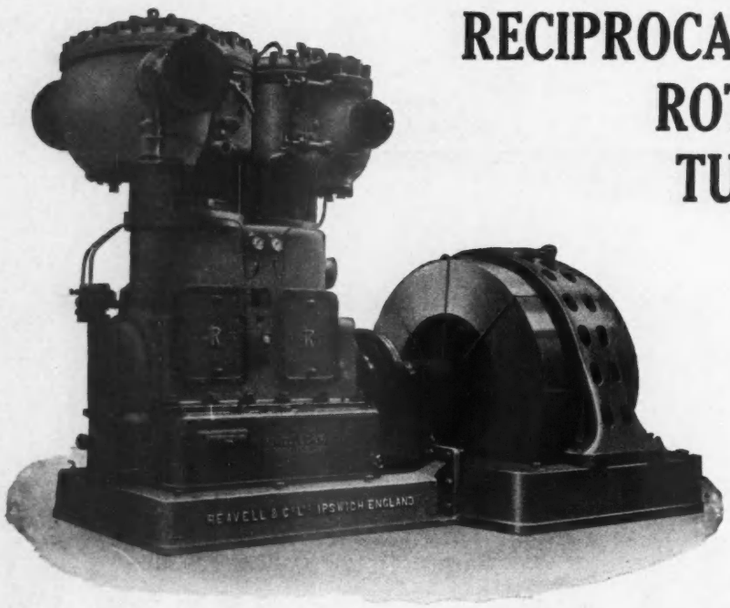

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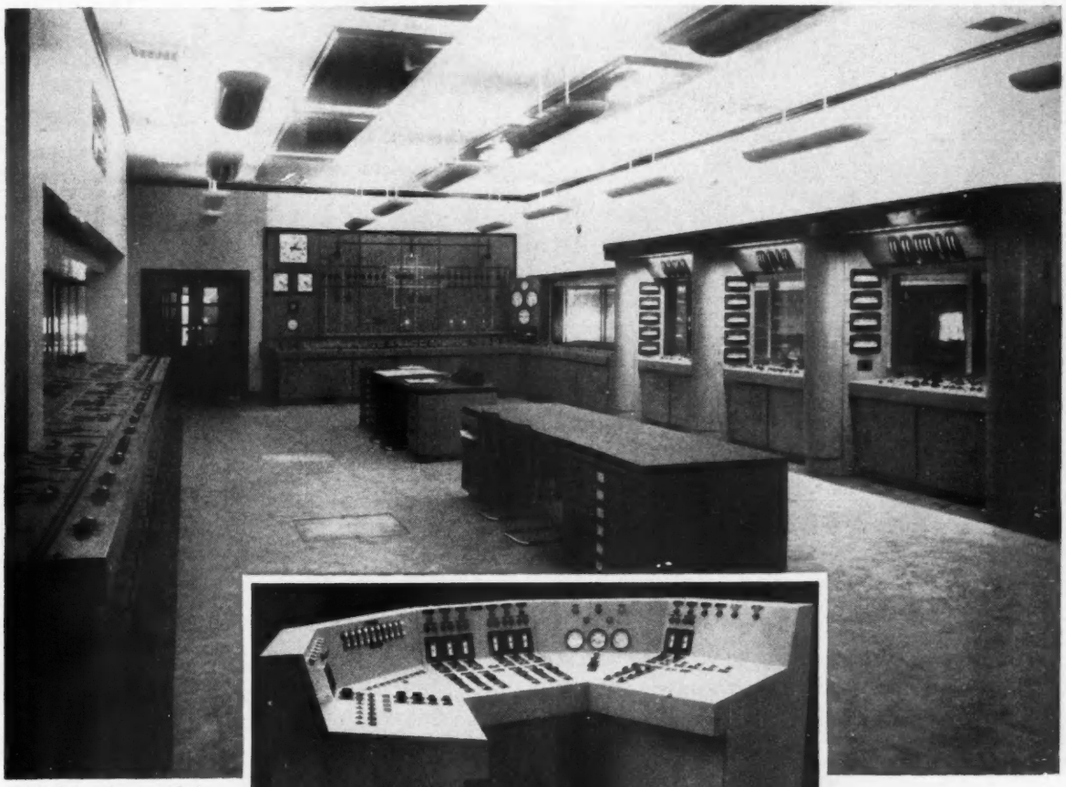
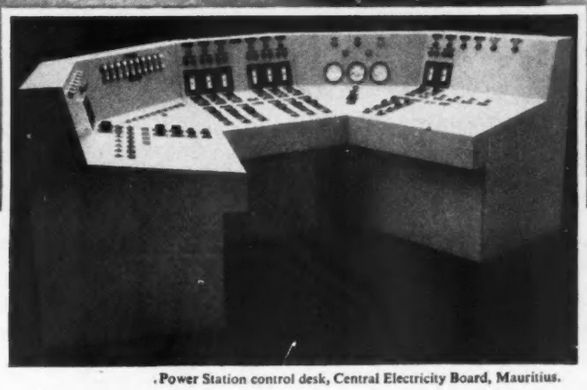


Main Control Room, Ashford Common Pumping Station of the Metropolitan Water Board.



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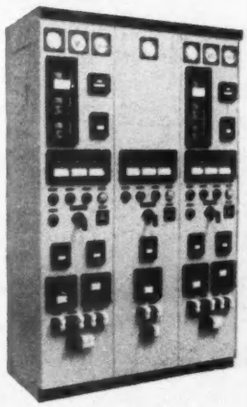

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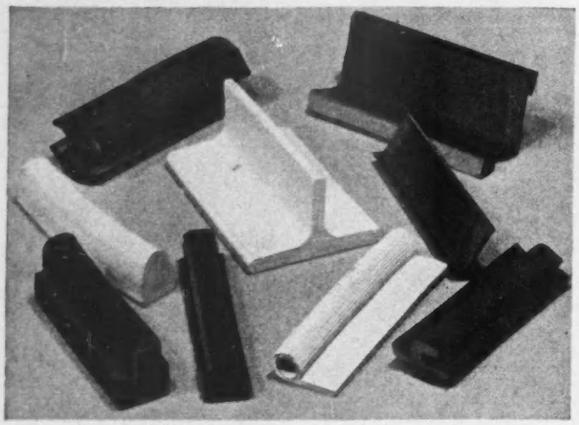

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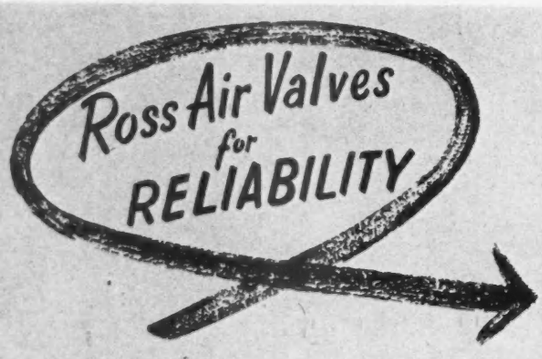

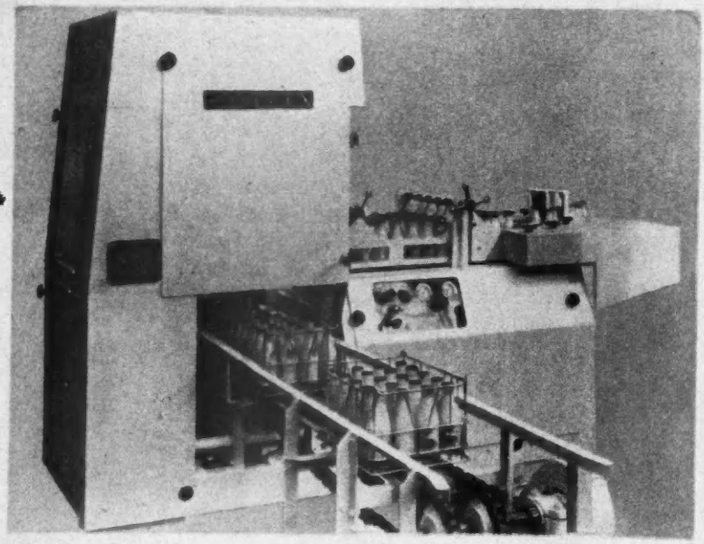

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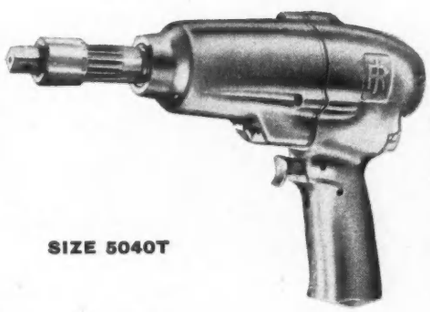

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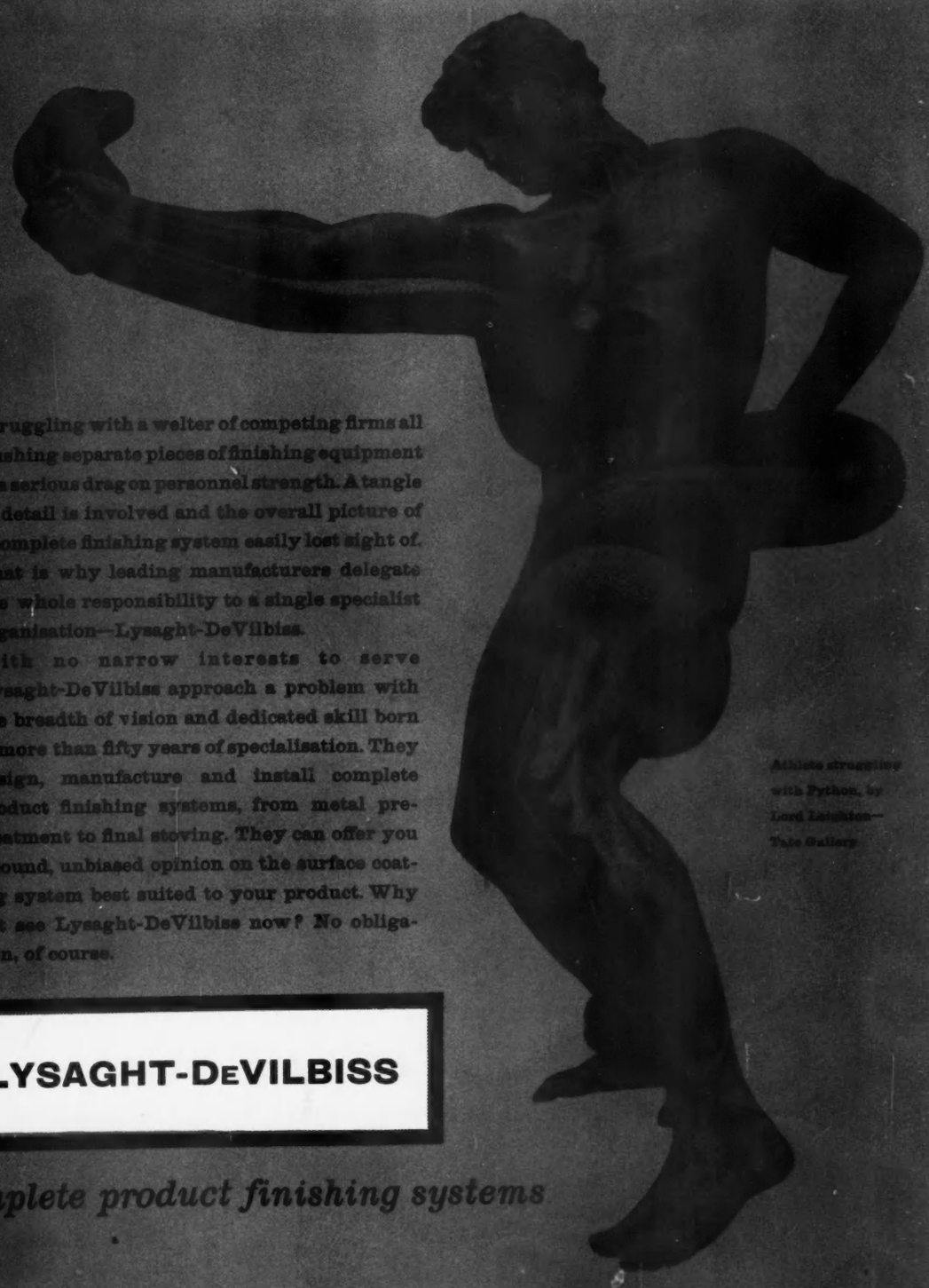

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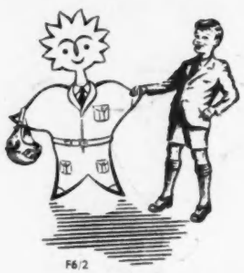
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